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VOL. 9, NEW SERIES APRIL, 1958 No. 2

Notes on the Helminths of Mammals in the Mountain Lake Region.[1] Part 3

The Genus Centrorhynchus in North America, With the Description of a New Species[2]

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The genus *Centrorhynchus* is a well defined group of "spiny-headed" worms belonging to the family Polymorphidae (Meyer, 1931), Palaeacanthocephala (Meyer, 1931), and class Metacanthocephala (Van Cleave, 1948). The species of this genus usually reach sexual maturity in the alimentary tract of birds. The most striking feature of this genus is the origin of the proboscis receptacle at approximately the mid-point of the longitudinal axis of the hook-covered introvert. The confusion which existed in the early anatomical studies of this genus, due to the attachment of the proboscis receptacle in the middle of the proboscis, has been clearly resolved by Van Cleave and Bullock (1950). They defined the praesoma as the region from the cuticular collar or ring to the cephalic tip of the proboscis. The praesoma is then dichotomously separated into the neck and proboscis — the proboscis being the region from the hind edge of the basal root of the posterior hooks to the cephalic tip and the remainder of the praesoma is the neck. The neck is short and unspecialized. Since the point of attachment of the proboscis receptacle is not concerned with

[1] This investigation was supported in part by research awards from the National Science Foundation through Dr. Bruce D. Reynolds, Director of Mountain Lake Biological Station, during the summers of 1954, '55 and '56.

[2] From a dissertation submitted to the Graduate Faculty of the University of Virginia in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

demarking these gross body regions, there should be no confusion in anatomically separating the divisions of the praesoma.

The genus is poorly represented in North America, probably because of a lack of sampling. Five species have been attributed with certainty to the fauna of North America.

Van Cleave (1916) notes that Leidy in 1888 recorded the occurrence of "*Echinorhynchus caudatus* Zeder" in the swallowtail kite *(Elamoides furcatus)* and an owl *(Strix nebulosa)* and continues that it is impossible to determine whether the Acanthocephala described belongs to the genus *Centrorhynchus* or *Mediorhynchus*. In 1916 Van Cleave described *Centrorhynchus spinosus* from an egret *(Herodias egretta)*. The specific description was based on one immature female. Later Van Cleave (1940) discovered that he had misinterpreted Kaiser's (1893) description of *Echinorhynchus spinosus* from an unrecorded host from Florida. Van Cleave (1940) notes that several birds from Florida have been listed as hosts for this species.

Millzner (1924) described *Centrorhynchus californicus* upon the basis of encysted juveniles from the mesenteries of *Hyla regilla* (Pacific Coast tree frogs) captured in California. This species has not been encountered since Millzner's original description.

Ward (1940) recorded the occurrence of eleven encysted juveniles of an unidentified species of *Centrorhynchus* from the intestinal wall of *Natrix sipedon* (water snake) from Kentucky.

Van Cleave and Pratt (1940) described *Centrorhynchus conspectus* from *Strix varia varia* Barton (Barred owl) taken in North Carolina.

Van Cleave and Williams (1951) recorded the occurrence of *Centrorhynchus scanensis* Lundstrom, 1942, from *Ixoreus naevius naevius* (Gmelin) (Pacific varied thrush) taken from Douglas Island and near Juneau, Alaska. This species was described by Lundstrom (1942) from *Turdus merula merula* Linnaeus in Sweden. This is the only known species of this genus recorded from both the European and North American continents. Van Cleave and Williams (1951) suggest that the accidental introductions of the parasites by wandering birds and not seasonal migrants is the only plausible explanation of the distribution of *Centrorhynchus scanensis*.

Read (1950) was able to infect experimentally albino rats with *C. spinosus* recovered from the body cavity of *Thamnophis sertalis* (snake) captured near Houston, Texas. Twenty-eight days after feeding, he recovered mature specimens from the two experimentally fed rats. Although *C. spinosus* had previously been reported only from birds of

prey, Read notes a few species of this genus have been reported from mammals. *C. ninni* (Stossick, 1891) was described from *Putorius vulgaris* in Europe and its presence has been observed in this same species by several Italian workers; Chandler, in 1925, described *C. erraticus* from a cat taken in Calcutta; Fukui, in 1929, described *C. itatsinis* from *Luteriola itatsi itatsi* in Japan and Meyer, in 1932-33 reported immature specimens of *C. aluconis* (Muller, 1780) from *Felis catus*. Read (1950) states further that *C. ninni* may or may not ordinarily be a parasite of mammals. *C. spinosus* will develop either in birds or mammals, thus indicating that physiological host specificity is not high in the species and that it may not be strongly developed in members of this genus.

According to Read (1950), the researches of Chandler (1941), Lincicome (1943 and 1948), Moore (1946) and his own work indicate that the proboscis characters attain a static state, as far as taxonomic characters are concerned, quite early in the ontogeny of the worm. This static state is attained in the intermediate host when the worm is capable of establishing itself in the definitive host.

Centrorhynchus wardae sp. nov.
(figs. 1-8)

In July, 1954, the author recovered five specimens of the genus *Centrorhynchus* from the alimentary canal of *Spilogale putorius* (*L.*) The host was trapped at Castle Rock, approximately two miles northeast of the Mountain Lake Biological Station in Giles County, Virginia.

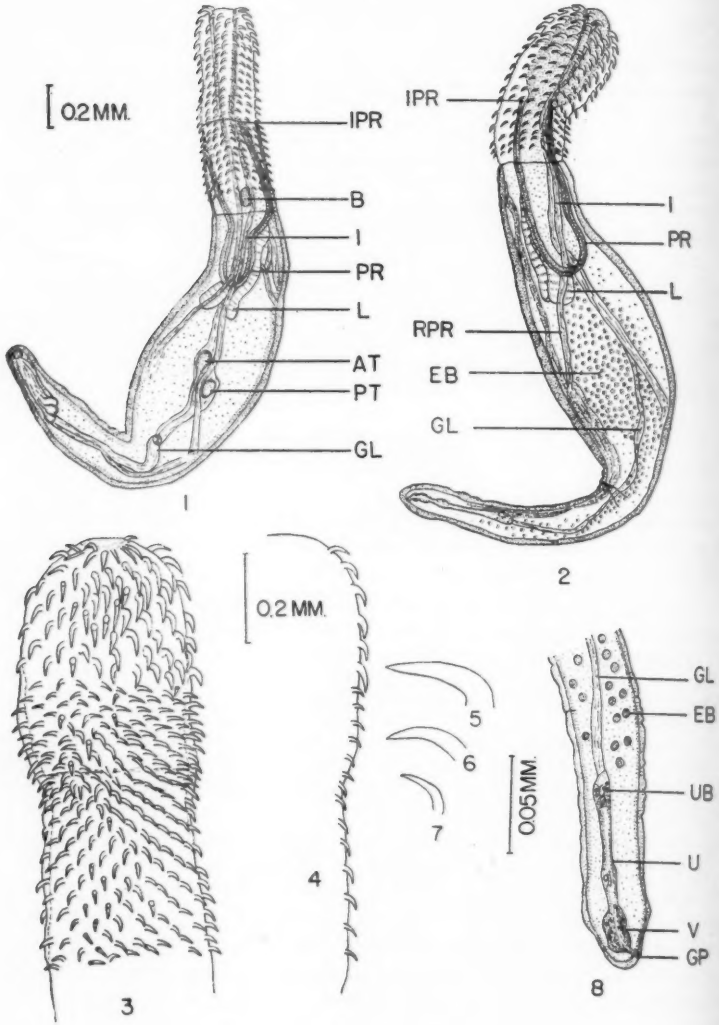
A detailed study of the specimens revealed distinct differences from previously described species of this genus and hence they are recognized as belonging to a new species, here described as *Centrorhynchus wardae*. The specific name is in honor of Dr. Helen L. Ward, University of Tennessee, a student of the Acanthocephala.

In an abstract concerning this species, the author (1956) created a *nomen nuder* in that the type specimens were not designated. However, the description and designated types of *Centrorhynchus wardae* included in this paper should rectify that error.

The specimens are only slightly morphologically advanced over described encysted juveniles of this genus from frogs and snakes. However, since the proboscis characters are the primary specific characters in this group and because they have attained a stable state in their development, there would be no difficulty in recognizing it upon later encounters.

Measurements are in millimeters and were determined with an ocular micrometer. Drawings were made with the aid of a camera lucida.

The worms are shaped somewhat like small swords — the praesoma


0.2 MM.
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GL
1
IPR
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PR
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RPR
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GL
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0.2 MM.
3
4
5
6
7
0.05 MM.
GL
EB
UB
U
V
GP
8

corresponding to the handle, and the trunk, although slightly bent toward the ventral side, resembles the attenuated blade (figs. 1 and 2). The males (fig. 1) are 3.000 mm. in length, with a maximum diameter, slightly posterior to the midpont of the longitudinal axis, of 0.508 — 0.562 mm. The females (fig. 2) are slightly larger than the males, having a total length of 3.815 — 4.125 mm., and a maximum diameter, slightly posterior to the midpoint of the longitudinal axis, of 0.594 — 0.636 mm. The proboscis (figs. 3 and 4) is 0.791 — 0.989 mm. long, (cephalic extremity to the caudal edge of the root-thorn junction of the most posterior hooks). It is 0.495 — 0.695 mm. long from the insertion of the proboscis receptacle to the cephalic extremity, and 0.265 — 0.396 mm. in length from the insertion of the proboscis receptacle to the caudal edge of the root-thorn junction of the posterior hooks. The enlarged portion of the proboscis is 0.353 — 0.480 mm. in diameter, and the posterior portion is 0.269 — 0.396 mm. in diameter. The proboscis receptacle inserts (IRP, figs. 1 and 2) slightly caudad to the midpoint of the longitudinal axis of the proboscis. The proboscis (figs. 3 and 4) is arrayed with numerous closely-set hooks. There are approximately 34 to 36 longitudinal rows of 18 to 20 hooks each. The hooks are of two distinct types (figs. 3, 4, 5, 6 and 7). The first five hooks (fig. 5) of each longitudinal row are more sturdy and strongly recurved than the posterior ones (figs. 6 and 7). The remaining hooks decrease gradually in size caudally. Although the roots are not all distinct, the anterior hooks appear to possess a well-developed root which becomes poorly developed in the medial hooks and appears to be absent in the basal hooks. The thorns of the anterior hooks (fig. 5) measure 0.049 — 0.069 mm., thorns of medial hooks

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Figs. 1-8. The morphology of *Centrorhynchus wardae*. The scale to the left of fig. 1 applies to figs. 1 and 2. The scale between figs. 3 and 4 applies to figs. 3, 4, and 8. The scale to the right of figs. 6 and 7 applies to figs. 5, 6, and 7.

Fig. 1. Immature male. AT, anterior testis; B, brain; GL, genital ligament; I, invertors of proboscis; IPR, insertion of proboscis receptacle; L, lemniscus; PR, proboscis receptacle; PT, posterior testis. Fig. 2. Immature female. EB, egg balls; GL, genital ligament; I, invertors of proboscis; IPR, insertion of proboscis receptacle; PR, proboscis receptacle; L, lemniscus; RPR, retractor of proboscis receptacle. Fig. 3. Proboscis. Fig. 4. Profile view of the proboscis. Note the size differentation of the lateral hooks. Fig. 5. Anterior hook from the proboscis. Fig. 6. "Medial" hook from the proboscis. Fig. 7. Posterior hook from the proboscis. Fig. 8. Optical section of the posterior extremity of an immature female, GL, genital ligament; GP, genital pore; EB, egg balls; U. uterus; UB, uterine bell; and V. vagina.

measure 0.033 – 0.049 mm. (fig. 6) and the thorns of the basal hooks measure 0.023 – 0.036 (fig. 7).

The praesoma is separated from the body proper by a cuticular ring or collar. It is not sharply differentiated from the body proper.

The lemnisci (figs. 1 and 2) measured from the insertion of the proboscis receptacle to the caudal tip are 0.989 – 1.060 mm. long. They are of equal length and extend into the body cavity only a short distance past the caudal edge of the proboscis receptacle.

The proboscis receptacle (PR, figs. 1 and 2) is a two-layered cylindrical muscular sac. In one preparation (fig. 1) the distal third of this sac appeared to be slightly constricted and the invertors of the proboscis passed through its apex. The invertors (I, figs. 1 and 2) of the proboscis extend from the apex of the proboscis to the blind end of the proboscis receptacle, where they pass through as the dorsal and ventral retractors of the proboscis receptacle (RPR, figs 1 and 2). They terminate in the subhypodermal musculature of the body wall.

What appears to be the "brain" (B, fig. 1) lies between the invertors of the proboscis slightly anterior to the cuticular collar.

The testes (AT, PT, fig. 1) are poorly developed and they lie in a rather wide genital ligament (GL, fig. 1). They are oval in shape and measure 0.069 – 0.082 mm. long and 0.043 – 0.053 mm. wide. A vas efferens arises at the caudal apex of each testis and passes posteriorly along the dorsal and ventral edge of the genital ligament. The two ducts were traced to the anterior edge of the four rather poorly differentiated cement glands. The anatomy of the male reproductive system between the cement glands and genital pore is poorly developed and obscure. The genital pore is sub-terminal. The genital ligament appears to extend from the posterior edge of the proboscis receptacle to the cement glands.

The lumen of the trunk in the female contains many poorly differentiated egg balls (EB, fig. 2). A genital ligament (GL, fig 2) extends from the caudal edge of the proboscis receptacle to the cephalic edge of the uterine bell. The uterine bell (UB, fig. 8) is not well differentiated and is not inflated (non-functional). Several nuclei are visible in the uterine bell. A tube-shaped non-specialized uterus (U, fig. 8) connects the uterine bell with the vagina (V, fig. 8). This latter organ is shaped like a figure 8; the anterior dilation appears cellular and the distal portion muscular. The distal dilation of the vagina is connected to the subterminal genital pore by a short, unspecialized portion of the vagina.

The trunk of both the male and the female is spineless.

Type Host – *Spilogale putorius* (Allegheny Spotted Skunk).

Type Locality — Giles County, Mountain Lake, Virginia.

Types: Holotype female and allotype male — U. S. N. M Helm. Coll. No. 38200. Series of paratypes in the author's collection.

The Allegheny Spotted Skunk is probably not the normal definitive host of *C. wardae*, but, in the light of Read's (1950) work, it is not outside the realm of possibility that it might mature in this host. The host was an adult lactating female. In an attempt to throw some light on the life cycle of this form, the stomach contents were analyzed. Portions of *Ambystoma* species were recovered and, since several species of the genus *Centrorhynchus* have been recovered from amphibia as encysted juveniles, it is probable that the skunk picked up the worm in this manner. A list of the identifiable invertebrates in the alimentary canal follows:

Diplopoda
Tulidae — not identified further.

Arachnoidea
Araneae — not identified further.

Insecta
Hymenoptera
Formicidae
Pheidale Sp.
Solenopsis molesta (Say)
Aphaenogaster rudis picea Em.
Camponotus hercullanus pennsylvanicus (DeGeer)
Others unidentifiable

Coleoptera
Staphylinidae — unidentifiable
Coccinellidae
Cycloneda munda (Say)
Rhyncophora (Curculionidae)
Lipidophorus setiger Horn
Others unidentifiable

Lepidoptera
Geometridae — not identified further

Homoptera
Membracidae
Platycotis vittata

Cercopidae
Philaenus leucophthalmus
Mollusca
Punctum minutissimum (Lea)

Comparisons:

C. wardae Holloway falls between the two groups of this genus: *C. californicus* Millzner with 48 longitudinal rows of hooks and *C. spinosus* (Kaiser), *C. conspectus* Van Cleave and Pratt; and *C. scanensis* Lundstrom, with a proboscis armed with not more than 34 longitudinal rows of hooks.

Key to the species of *Centrorhynchus* recognized from North American Hosts.

1. (a) Proboscis armed with 48 longitudinal rows of 21 to 22 hooks each. ..... *C. californicus* Millzner.
   (b) Proboscis armed with 34 to 36 longitudinal rows of 18 to 20 hooks each. ..... *C. wardae* Holloway.
   (c) Proboscis armed with not more than 34 longitudinal rows of hooks. 2

2. (a) With 22 to 23 hooks in each of 30-34 longitudinal rows of proboscis hooks. Hard shelled embryos 0.050 – 0.060 mm. long
   C. spinosus (Kaiser).
   (b) With 16 to 19 hooks in each of 26 to 28 longitudinal rows of proboscis hooks. Hard shelled embryos 0.060 – 0.078 mm. long.
   C. conspectus Van Cleave and Pratt.
   (c) With 10 to 11 hooks in each of 22 longitudinal rows of proboscis hooks. Hard shelled embryos 0.078 – 0.084 mm. long.
   C. scanensis Lundstrom.

The accompanying table shows the differences between the recognized species of the genus *Centrorhynchus* from North America. *Centrorhynchus wardae* can be clearly differentiated from all other species of this genus upon the basis of the number of longitudinal rows of hooks, the number of hooks per row and the size of the hooks.

Summary

1. *Centrorhynchus wardae* sp. nov. with 34 to 36 longitudinal rows of 18 to 20 hooks per row from *Spilogale putorius* is described and figured.

2. The analysis of the gastric contents of *S. putorius* revealed that the skunk probably became infected upon ingesting *Ambystoma* species. The identifiable invertebrates recovered are listed.

3. *Centrorhynchus californicus, C. wardae, C. spinosus, C. conspectus,* and *C. scanensis* from the fauna of North America are compared and a key to the species is given.

Acknowledgments

The author is indebted to Dr. William E. Bickley, Department of Entomology, University of Maryland, and Dr. P. W. Oman and staff, Insect Identification and Parasite Introduction Section, U. S. D. A., for the identification of insects from the alimentary canal of the skunk. Thanks are also extended to Mr. Allen McIntosh, Animal Disease and Parasite Research Branch, U. S. D. A., and Dr. Helen Ward, Department of Zoology, University of Tennessee, for verifying the identification. He also wishes to express his obligations to Dr. Bruce D. Reynolds, University of Virginia, for his interest and criticism during the course of the work.

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TABLE I. COMPARISON OF RECOGNIZED SPECIES OF
MEASUREMENT

	Number Longitudinal Rows of Hooks	Number Hooks Per Row	Length of Hooks			Length of Proboscis
			Anterior	"Medial Hooks"	Posterior	
californicus	48	21 to 22	.052	.042	.031	.880
wardae	34 to 36	18 to 20	.049 to .069	.033 to .049	.023 to .036	.791 to .989
spinosus	30 to 34	22 to 24	.036 to .060 Hooks of two Distinct Types			1.000 to 1.300
conspectus	generally 26 to 28 sometimes 30 to 32	generally 17 to 18 extremes 16 to 19	generally .050 to .065 extremes .044 to .073	.050 to .060 extremes .039 to .065	.040 to .057	1.100 to 1.750
scanensis	22	10 to 11	.030 to .054			.600 to .700

THE GENUS *CENTRORHYNCHUS* FROM NORTH AMERICA IN MILLIMETERS

Width of Proboscis		Embryos	Body Dimensions	Proboscis Receptacle	Length of Lemnisci	Host
Anterior	Posterior					
Figure shows no differentiation between anterior and posterior portions. .200			Artificially excysted juveniles 3.150 by .140-.380	.940 by .360	.540	*Hyala regilla* (Pacific Coast tree frogs) (Abdominal mesentery)
.353 to .480	.269 to .396		Immature specimens in small intestine. Male 3.000 by .508-.562 Female - 3.815 -4.125 by .594-.636	.579 .805 long	.989 to 1.060	*Spilogale putorius* (Allegheny Spotted Skunk) (small intestine.)
.170 (tip)	.350	.050-.060 by .020-.024	Female - 40-66 by 1.500. Male 30-45 by .900-1.100			*Herodias egretta* (egret) (intestine.)
Anterior region swollen, constricted at insertion of proboscis receptacle and followed by a short enlarged portion.		.060-.078 by .021-.026	Female 28-55 by 1.000-1.500 Male 23-35		Extend 1.500 beyond proboscis receptacle.	*Strix varia varia* (Barred owl) (small intestine.)
.300 to .400 anterior portion ovoid, and posterior portion conical.		.078-.084 by .021-.024	Female 10.000-14.500 by 1.500-1.800. Male 7.400-8.300 by 1.000	1.000 long	1.000 to 1.400	*Ixoreus naevius naevius* (Pacific varied thrush)

Genus *Centrorhynchus* (Acanthocephala) from the Barred Owl. *Journ. Parasit.*, 26 (4): 297-300.

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Origin Of The Blue Ridge Escarpment Directly Southwest Of Roanoke, Virginia[1]

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RICHARD V. DIETRICH

INTRODUCTION

Most of the observations reported upon in this paper were made in Floyd County which is directly southwest of Roanoke, Virginia. The area is of special interest so far as determining the origin of the Blue Ridge Escarpment because part of the country is within the irregular mountain ridges subdivision of the Blue Ridge Province and part of it is within the upland subdivision of the province (fig. 1).

THE BLUE RIDGE PROVINCE

The Blue Ridge Province is a long, narrow area that extends from south-central Pennsylvania through Maryland, Virginia, Tennessee, and North Carolina to northwestern Georgia. Northeast of Roanoke, Virginia, the Blue Ridge Province consists essentially of an irregular mountain ridge that ranges from a single ridge with width of less than two miles to a complex group of ridges with an overall width of ten to twelve miles. Southwest of Roanoke, the province is a slightly to highly dissected upland that ranges up to nearly seventy miles in width. The differences between these two rather distinct parts of the province are mainly the result of their different drainage histories. Northeast of Roanoke both sides of the province are characterized by rather well defined escarpments and both sides are drained by tributaries of streams that flow to the Atlantic Ocean. Southwest of Roanoke the Blue Ridge is a broad upland bordered on the east by the prominent Blue Ridge Escarpment and on the west by an irregular group of mountains, the Blue Ridge Front Mountains. The Blue Ridge Escarpment is drained by tributaries of Atlantic Coast Streams whereas most of the Upland is drained by tributaries of streams that flow westward to the Gulf of Mexico. From Floyd County, water that flows to the ocean via Gulf of Mexico drainage system arteries travels as much as 5.5 times as far as that which reaches the ocean via direct Atlantic slope steams (Gannett, 1901).

BLUE RIDGE ESCARPMENT

Early literature concerning the Blue Ridge Escarpment was summari-

[1] This is a summary of a paper presented at the meeting of the Southeastern Section of the Geological Society of America held at Morgantown, W. Va., May 17, 1957.

zed by Davis (1903). Different modes of origin for the escarpment were discussed by Wright (1927) and later summarized by Fenneman (1938). White (1950) wrote the most recently published paper concerned chiefly with the origin of the escarpment.

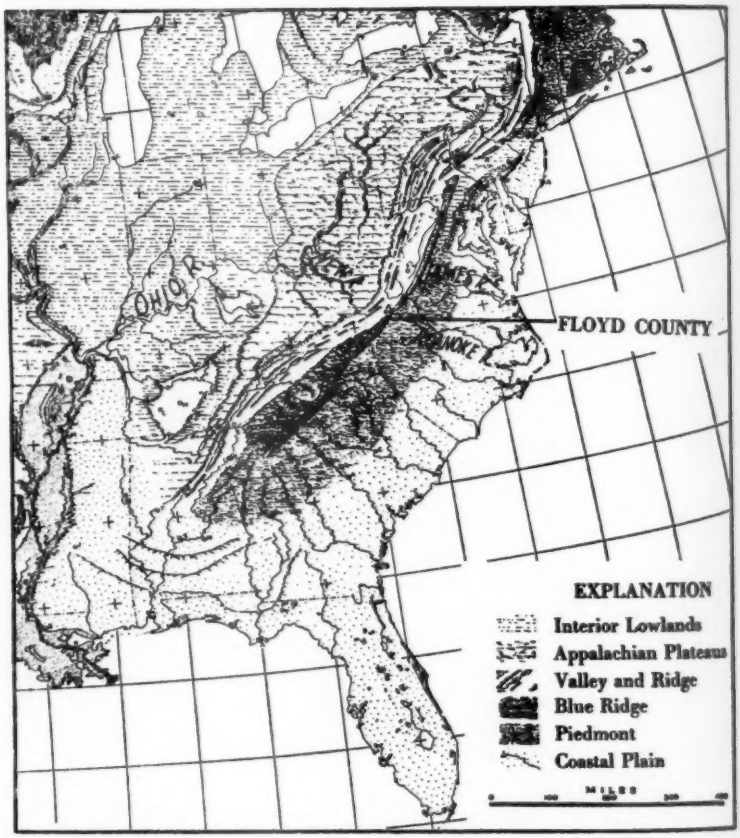

Fig. 1. Physiographic diagram of the eastern United States with location of the Floyd County area indicated. (Base map, copyright A. K. Lobeck; reprinted by permission of A. K. Lobeck and The Geographical Press, a division of C. S. Hammond & Company.)

There is no general agreement in the literature concerning the origin of the Blue Ridge Escarpment. Possible modes of formation which have been considered are: 1) marine erosion along a sea cliff, 2) erosion controlled by a marked superiority of resistance to weathering and erosion of the rocks of the Blue Ridge over resistance to weathering and erosion of the rocks of the Piedmont, 3) monoclinal flexing, 4) faulting, 5) westward migration of an asymmetric divide, and 6) different combinations of these. The discussion presented here, although it is necessarily somewhat general, pertains mainly to the part of the escarpment along the southern border of Floyd County.

The possibility that the Piedmont represents a surface of marine planation and that the Blue Ridge Escarpment was formed originally as a sea cliff has never been considered seriously, so far as the writer knows. Triassic sedimentation on the Piedmont; the absence of Jurassic sediments on either the Piedmont or beneath the late Mesozoic and Cenozoic Coastal Plain sediments; Cretaceous and Cenozoic sedimentation, much of which is reported to be of near shore type, on the site of the present Coastal Plain; and ocean terrace formation on the Coastal Plain during the Pleistocene can be offered as at least permissive evidences against this possible genesis for the escarpment in post-Paleozoic time. Formation of the present escarpment or even of an ancestral escarpment by marine erosion (or by any other means) before Triassic block faulting appears to be highly unlikely when one considers the positions of some of the border faults of the Triassic troughs in relation to the Blue Ridge.

The possibility that the escarpment was formed as a consequence of erosion controlled by the presence of relatively resistant rocks underlying the Blue Ridge and the presence of relatively less resistant rocks underlying the Piedmont is untenable. The Lynchburg formation underlies much of Floyd and Carroll counties of the Upland and also much of Franklin and Patrick counties of the adjacent Piedmont. Nearly all of the diverse rocks that constitute this formation appear to offer nearly the same resistance to weathering and erosion. Further, the lithological contacts that are present are not parallel to the scarp.

Monoclinal flexing as the control that initiated formation of the Blue Ridge Escarpment was first suggested as a possibility by Hayes and Campbell (1894). Johnson (1933) and Fenneman (1938) apparently also believed that warping ("differential uplift") may have been at least locally important. In the opinion of the writer, the structure of the involved areas is not known sufficiently well to rule out or to support this idea. However, data obtained during reconnaissance geologic mapping of the areas involved plus some of Wright's (1928) observations, *e.g.*, ". . . the Piedmont surface juts into the base of the Blue Ridge." (*op. cit.*, p. 329), pose definite difficulties for this hypothesis.

The possibility that the Blue Ridge Escarpment is some type of fault or fault line scarp has appealed, at least momentarily, to nearly everyone who has made only cursory examination of the escarpment or of topographic maps that include the feature. Few geologists have championed the hypothesis. Fenneman (1938) reported that Campbell believed faulting was important so far as formation of certain segments of the escarpment. White (1950:1309) concluded that "The Present Blue Ridge scarp seems to have been produced by a late Tertiary fault — the Blue Ridge border fault." Stose and Stose (1951), in a short discussion, cited evidences that appear to be incompatible with White's hypothesis — at least for part of the eastern escarpment.

Considerations of the main arguments given in favor of the fault-control hypothesis show that: 1) The suggestion that the presence of an escarpment on the east and lack of one on the west is incongruous, disregards two facts; (a) there are broad outcrops of resistant Silurian, Mississippian, and Pennsylvanian sandstones in the western part of the Valley and Ridge Province west of the province which have acted as temporary base levels for westward flowing drainage, and (b) there is an escarpment, one nearly as imposing as the eastern escarpment, along the western boundary of that part of the Blue Ridge Province drained by Atlantic Slope streams rather than by Gulf streams. 2) Statements concerning the necessity that the escarpment be a divide throughout its length do not consider the possibility of any stream piracy of upland streams by Atlantic Slope streams. 3) The straightness of a line constructed so as to connect the foot of the spurs of the escarpment has long been a "bone of contention" (Davis, 1903; Wright, 1927; White, 1950; and White, 1953). In the present writer's opinion, if the topography along the escarpment between the North Carolina-Virginia state line and a point just south of Roanoke, Virginia, is examined on recent aerial photographs (pl. 1), and/or topographic sheets (Elliston and Stuart, Virginia quadrangles and Bluefield, West Virginia, Virginia, Kentucky and Winston Salem, North Carolina, Virginia, and Tennessee Army Map Service Topographic Sheets), it is quite apparent that, no matter what criteria are used to locate the terminations of the spurs, a line connecting them would not be straight but extremely irregular (fig. 2). 4) The idea that the west-flowing streams must have undergone an uplift which did not affect the east-flowing ones because of the discrepancy in degree of their rejuve-

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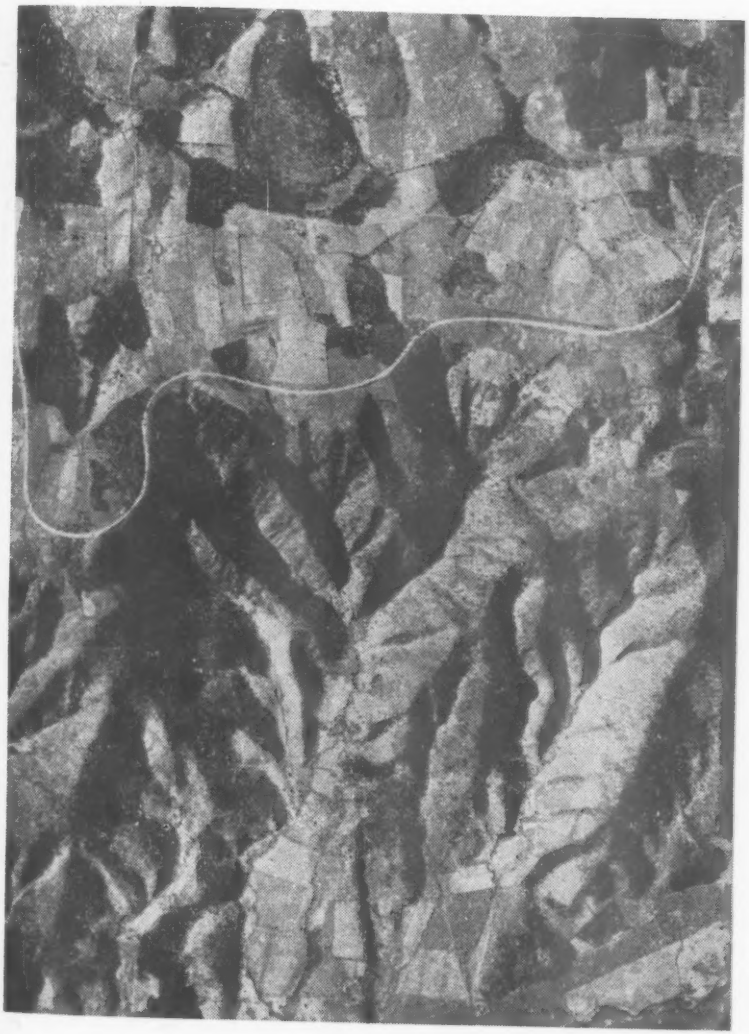
Plate 1. Part of the Blue Ridge Escarpment; the area is located 22 miles southwest of Roanoke and 22 miles southeast of Blacksburg; approximate scale of aerial photograph is 1:20,000; bottom of photograph is east. (Photographed by U. S. Department of Agriculture, Soil Conservation Service.)



nation appears to overlook the alternatives that rejuvenation of the upland streams may represent the removal of one or more temporary base level(s) at the western edge of or downstream from the upland, the shortening of the overall distance that waters of these streams have to travel to reach the ocean as the result of the establishment of the Ohio River, or a combination of these. 5) So far as the suggestion that out-

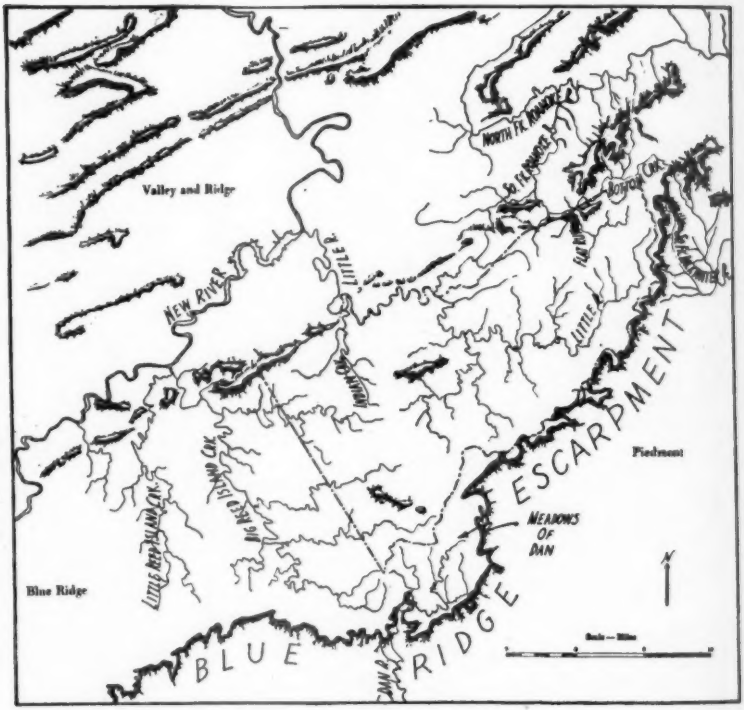


Fig. 2. Diagram showing the Blue Ridge Escarpment of southwestern Virginia, some of the Blue Ridge Front Mountains, and the main drainage arteries of Floyd County and adjacent region. (Bases for this diagram are Blacksburg, Elliston, and Stuart, Virginia U. S. G. S. quadrangle sheets and Bluefield, West Virginia, Virginia and Kentucky and Winston-Salem, North Carolina, Virginia, and Tennessee Army Map Service Topographic sheets.)

lying mountains along the foot of the escarpment may be topographic correlatives of the higher mountains on the upland, in the area under consideration here, the outlying mountains in front of the escarpment as defined by White would fit into his scheme: Chestnut, Smith, and Turkeycock mountains are 700 to 900 feet above the surrounding Piedmont, which correlates well with the fact that Buffalo Mountain and Wills Ridge in Floyd county are, respectively, approximately 1,000 and 800 feet above their surrounding upland hilltops. Further, these figures are notably less than the height of the escarpment of the area. However, if the criteria commonly used to fix the position of the escarpment of North Carolina were employed to fix its position in this area, such prominences as Bull Mountain (3212 feet) and perhaps even Cahas Knob (3560 feet) and Rocky Mountain (2910 feet) would be considered as on the postulated downthrown block. These mountains, considered as outlying mountains on the Piedmont, not only have approximately the same elevations as the adjacent upland (2600 to 3100 feet), they have no counterparts atop the adjacent upland. 6) Conditions such as those cited by White, for certain areas where the trace of the postulated fault transects many different types of rocks do not obtain in this area.

The only tangible structural evidence offered with respect to the actual position of the postulated "Blue Ridge border fault" was the presence of minor faults and slickensided surfaces parallel to schistosity of crystalline rocks of the Piedmont and of "offsets" along the escarpment. White (1950) placed emphasis on the fact that he was able to find slickensided surfaces and other phenomena in roadcuts close to the trace of the postulated fault. If a fault were to be located objectively in the area southeast of the escarpment adjacent to Floyd County by using the same criteria, the conclusion would be that an extremely wide belt (actually nearly all of the area west of the Fall Line) constitutes a fault zone. One of the "offsets" in the escarpment was located as near the eastern end of Floyd County. This "offset" (the one located as ". . . near Callaway and Junta (Christiansburg, Virginia — West Virginia Sheet), where the displacement is about 3 miles.") is not apparent to the writer on the more recent, larger scale Elliston quadrangle sheet that supercedes the Christiansburg sheet. Further, if this "offset" exists, Cahas Knob (see above) would be on the downthrown block. Also, examination of this area has failed to reveal any evidence of a cross structure of the magnitude suggested.

Because of these data the writer can not support the fault control hypothesis of origin for the Blue Ridge Escarpment of this area. Nonetheless, he would be hesitant to deny emphatically the possibility that the escarpment is some type of erosional fault scarp. If such be the case, however, it would appear that the original fault scarp must have existed far southeast of the present erosional scarp and also that, at

least along part of its length, it would have been an appreciable distance southeast of White's (1950) postulated "Blue Ridge border fault." (No such fault has been recognized to date.)

The hypothesis that the Blue Ridge Escarpment of southwestern Virginia and North Carolina was formed by erosion accompanying westward (northwestward) migration of the asymmetric divide between Atlantic Slope Drainage and Gulf of Mexico Drainage and that the escarpment may have evolved to, rather than originated as, an escarpment was introduced by Davis (1903). Subsequent workers (*e.g.*, Wright, Fenneman, Thompson) have embraced this idea at least to the extent that they have noted that erosion attending migration of the divide has sculptured the escarpment to its present appearance. Thompson (1939) noted that in his opinion ". . . the divide has been migrating northwestward for a long time and is in places as much as 100 miles northwest of its original position."

Apparently no one has denied the fact that the present escarpment owes most, if not all, of its present appearance to weathering and erosion accompanying the westward migration of the asymmetric Atlantic-Gulf Divide. The obvious headward growth of the vigorous streams of the escarpment as they encroach upon the drainage basins of the upland streams, the piracies of Gulf drainage by Atlantic streams, and numerous other features attest to this. However, the possibility that the escarpment actually originated as a consequence of the westward migration of the divide is not so readily accepted.

Many features mentioned above appear to favor this hypothesis. A few additional features not considered, or at least not elaborated upon, are also pertinent. 1) Nearly all mountains of the southern part of the Piedmont Province of Virginia are within five to twelve miles of the Blue Ridge Escarpment. 2) With few exceptions, the outlying mountains decrease in height and number with increased distance from the escarpment. 3) Alluvial boulder deposits occur locally on the upland near the escarpment. 4) The distance between the headwaters of main Atlantic slope streams and the coast are essentially equal from the Potomac River southward; *i.e.*, all main streams have nearly equal lengths with deviations from this, easily explainable when comparisons of resistances of bedrocks along the stream courses and lengths of courses derived by piracy are considered. 5) The Piedmont Province is about 30 miles wide at the Potomac and about 160 miles wide in southern Virginia. 6) The width of the Blue Ridge Province and the heights of its prominences in general increase in magnitude from northeast to southwest. 7) Geophysical work suggests (Miller, 1937) that there probably was continuous or intermittent eastward tilting in this region during most of Mesozoic and Cenozoic time.

The location and distribution of mountains along the foot of the escarpment is exactly what one would deduce as a consequence of westward migration of the highly asymmetric Gulf-Atlantic divide; they are difficult to correlate with any of the other hypotheses unless activities set up under those hypotheses are applied to the area southeast of the outliers. The presence of large stream valleys, swamps along valleys, and alluvial boulder deposits on the upland near the escarpment indicates the former presence of large streams there. This suggests that a sizable part of the Gulf drainage area previously existed east of the present escarpment. (The loss of headwaters, of course, also could be accounted for by warping, or by faulting as well as by migrtaion of the divide.) The facts concerning the widths of the area drained by the Atlantic Slope streams and of the Piedmont Province considered in conjunction with the fact that the Blue Ridge is, in general, higher, broader, and less deeply dissected in the southern part than in the northern part of Virginia, not only appear to be consistent with the divide-migration hypothesis but appear to require that any hypothesis of origin for the escarpment be combined with this hypothesis if it is to warrant serious consideration. Corroborative data are: 1) nearly all Atlantic Slope streams are essentially perpendicular to the general slope of the land except where they have courses underlain by relatively nonresistant rocks (Thompson, 1939); 2) areas crossed by the streams and underlain by resistant rocks are typically sites of residual mountains and ridges; and 3) the prominences nearer the coast are more highly dissected than are those farther from it — apparently because the ones nearer have been attacked on all sides by the more vigorous Atlantic Slope streams for longer periods than the ones more remote from the ocean. Further, if the area did undergo eastward tilting throughout much or most of Mesozoic and Cenozoic time, Atlantic Slope streams certainly would have been steepened and thus would have had their advantage over Gulf streams not only maintained but possibly even increased intermittently; this would have prompted migration of the divide throughout the period.

Different combinations of hypotheses, *i.e.* eclectic hypotheses, of origin for the escarpment are innumerable. Those most commonly suggested combine warping or faulting with subsequent erosion along the westward migrating, asymmetric Atlantic-Gulf Divide. It is quite possible that one of these combination hypotheses will prove to be correct.

In summary, the present writer believes that the data favor the hypothesis embracing formation of the escarpment as the result of the westward migration of the asymmetric Atlantic-Gulf of Mexico Divide. It appears that the Blue Ridge Province, from one end to the other, was at one time essentially an upland drained mainly to the west; that the area was attacked by eastward flowing streams; that these streams breached the upland and then attacked the breached portions from all sides; and that dissection

thus initiated led to detachment of areas from the main upland to form distinct ridges and mountains. If this sequence of events is correct, apparently the Blue Ridge to the northeast of Floyd County has passed through this whole sequence of events, the Upland of Floyd County and to the southwest has not been breached and thus retains pre-breaching characteristics, and the intervening northeastern part of Floyd County and the area adjacent to the northeast have the characteristics of intermediate steps in the sequence. It is obvious that this last named area was part of the Upland at one time and it is equally obvious that the features that indicate this will not persist long, geologically speaking, and that the area then will be indistinguishable from the Blue Ridge Mountain Ridge (s) to the northeast.

GEOMORPHIC HISTORY

All reported data appear to fit best into the following general geomorphic history. As will become apparent, many of the suggested events have been introduced previously (note especially Fenneman, 1938, and Thompson, 1939, and 1949).

Evidence indicates that New River probably existed in Mississippian time and possibly earlier (Branson, 1912; Shuler, 1945). It probably has flowed westward throughout its history. Although the Blue Ridge intermittently may have had less relative prominence than it has at present apparently it has been some sort of topographic barrier since at least late Paleozoic and possibly since late Precambrian time. The Blue Ridge may occupy essentially the position of, although it probably is west of, the ancient divide between the "Appalachian Geosyncline" and the basins represented by metamorphosed Paleozoic sediments to the east. Any evidence of events during the period between the end of Paleozoic sedimentation and establishment of the Mississippi Embayment-Atlantic Divide prior to Triassic block faulting appears to have been obscured beyond present day recognition. In any case, none has been recognized to the present. Immediately preceding the high angle faulting of the Palisades Disturbance, the Blue Ridge was much less prominent than it is today. On the east, the boundary of the Blue Ridge with the area now designated Piedmont Province would have been a nearly symmetrical divide between the eastward – and westward-flowing streams. On the west, it would have been essentially continuous, geomorphologically though not lithologically, with the area now known as the Valley and Ridge Province. The stage in the classical geomorphic cycle reached in this area at that time can only be guessed – conceivably, although doubtfully, the mature surface now represented on the Upland was formed as early as this. The divide between the eastward – and westward-flowing streams would have been east of the present Gulf of Mexico-Atlantic Divide. The presence of

boulders of Paleozoic sedimentites in the Triassic Potomac Basin suggests that the Potomac or an ancestral Potomac already had part of its course west of the position of the present Blue Ridge or that Paleozoic sedimentites existed at the western edge of that basin at that time. The fact that no Paleozoic sedimentite fragments have been found to occur in the Triassic Basins south of the Potomac Basin plus the apparent control of the northeastward-flowing parts of the courses of the James and Roanoke rivers by these basin areas suggest that these two master streams probably had not attained the position of the present Blue Ridge-Valley and Ridge boundary by this time, *i.e.*, the area underlain by the Paleozoic sedimentites drained by westward-flowing streams. The ancestral divide, especially south of the Potomac, may have been shifted as a result of Palisades faulting. After this faulting and consequent Triassic sedimentation and before initiation of Cretaceous sedimentation in the area that includes and is east of the present Coastal Plain, there was erosion that involved at least partial planation of both crystalline rocks and Triassic sedimentites (Spangler and Peterson, 1950). It would have been during this planation that the so-called Fall Zone peneplane was formed. By the time Cretaceous sedimentation began and possibly prior to that time, distance-to-base level advantage of the eastward-flowing streams over that of the westward-flowing streams already had been established, regardless of whether the westward-flowing waters emptied into the Mississippi Embayment or into the ocean via the stream that flowed through the present position of Lake Erie and its trunk stream. Because of this advantage, the eastward-flowing streams were destined to render the divide asymmetric and to encroach upon the drainage basin of the westward-flowing streams. At least intermittently throughout the late Mesozoic and Cenozoic, encroachment proceeded — possibly enhanced by warping, eustatic changes in sea level, or a combination of these — so the area drained by the westward-flowing streams became relatively reduced in size while the area drained by the eastward-flowing streams became enlarged. After the James and Roanoke rivers eroded headward, in turn, to the position of the present eastern border of the Valley and Ridge province, reduction of the drainage areas of the westward-flowing streams was hastened not only because the area underlain by the relatively nonresistant calcareous and argillaceous sedimentary rocks was then attacked by the more vigorous Atlantic streams but also because major streams of the subsequent drainage systems of the Valley and Ridge Province flowed in a direction nearly perpendicular to the Atlantic slope streams which meant that their capture by the Atlantic streams involved relatively large drainage areas. Further, the more resistant rocks of the Blue Ridge Province also were reduced more rapidly after this boundary was attained by the Atlantic Basin streams because they then were attacked not only on the east but on many sides by the vigorous streams of the Atlantic Basin. As this process continued the Blue Ridge Province has been and contin-

ues to be reduced to a series of linear ridges and individual mountains drained to the east. The change in general character of the Blue Ridge Province from a broad upland to a series of linear ridges and mountains has progressed from northeast to southwest because the northeastern part of the province is nearer the present (and previous) coast line than is its southwestern part. Unless interrupted these processes will continue until all of the present day Blue Ridge Province has been reduced first to a series of ridges and mountains and finally to the point that, other than grainwise, the Piedmont and Valley and Ridge provinces will be geomorphologically continuous, with no intervening Blue Ridge, and drained to the east. The changes in character will, of course, be preceded by changes of features of the Valley and Ridge subprovince south of the Roanoke-New Divide into features more similar to those of the Valley and Ridge subprovince northeast of this divide. The ultimate, if natural or artificial changes do not interrupt the cycle in such a way as to preclude it, will be the establishment within or west of the Appalachian Plateau of an essentially symmetrical Atlantic-Gulf divide at an elevation near sea level.

Probably few, if any workers would deny that uplift has played a part in the geomorphic history of the region. The great volume of sediments that comprise the Coastal Plain sequence attest to this, especially if they were derived mainly from the area between the Fall Zone and a divide east of the present Blue Ridge. To the present, no evidence, marine sedimentation records notwithstanding, has been found that clearly indicates definite spatial and temporal aspects of such uplift. The presence of at least some of the coarse sediments in the Coastal Plain and Mississippi Embayment-Gulf of Mexico sequences, for example, may reflect removal of temporary base levels, eustatic changes in sea level, changes in climate, or a combination of such controls rather than uplift. Certainly at least some of such controls rather than uplift. Certainly at least some of the recent (Pleistocene and post-Pleistocene) rejuvenation (s) can be attributed to differences in stream volumes mainly dependent upon changes in rainfall; to relative elevation above sea level dependent upon changes in sea water volume in response to glaciation(s) and deglaciation(s); and, as is in the case of New River, to changes in overall distance from headwaters to the ocean – the inception of the Ohio River certainly shortened the distance between the headwaters of New River and the ocean. (Perhaps even the recent rejuvenation of New River, which is indicated by downcutting in old alluvial deposits along the edges of which are perched colluvial deposits whose relatively long stability is indicated by marked disintegration of included quartzite boulders, reflects one or more of these controls rather than uplift.)

SUMMARY

The topography and drainage of the area directly southwest of Roanoke in southwestern Virginia, are of peculiar interest because the area is located at the boundary between two more-or-less distinct parts of the Blue Ridge Province — the irregular mountain ridges drained by Atlantic Coast streams and the dissected upland drained almost wholly by streams of the Gulf of Mexico Drainage Basin. Evidence here suggests that the location, as well as the character, of the present Blue Ridge Escarpment is the result of migration of the asymmetric Atlantic-Gulf Divide.

A general geomorphic history is suggested for the province for the time subsequent to the late Paleozoic establishment of New River.

ACKNOWLEDGMENTS

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Report On A Gastrotrichan Species From Ashland, Virginia

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Search for *Polymerurus* in a water sample taken from a garden pool July 31, 1956, on the college campus, revealed a chaetonotid gastrotrich of graceful body similar in shape to that of *Lepidodermella squamata*. Its somewhat tesselated appearance and extraordinarily long spines, which originated a third to a half the distance from the anterior end, were distinctive. Long spines occurred laterally at 3 spaced posterior levels, all extremely sharply pointed. The first and most conspicuous were arranged in a semicircular fashion about the widest part of the main body like a hoop skirt. Anteriorly, the neck and the head bore short thorns with basal plates roughly rhomboidal as in *Polymerurus*. Hairs were dimly visible protruding through the mouth opening. The intestine was coarsely granular. Two clear vesicles appeared posteriorly, one per side. The head was weakly 5-lobed with a pair of clear, lateral bodies. This particular specimen did not stop twisting, turning, bending, straightening and moving about.

Four subsequent collections yielded a total of 10 individuals positively identified as being alike. Two additional specimens, observed under the dissecting binocular and thought to be of the same chaetonotid species, were transferred into crystallization dishes of pool water. It was hoped that they would adjust to the changed conditions and multiply within doors. Repeated checking of the containers failed to show that they did so.

An attempt was made to kill, fix, and mount 3 of the 10 animals with unsatisfactory results. Studies and measurements of the 7 others were carried out following immobilization by MgS04, iodine, Schaudinn's fixative, and formalin. No chemical solution used was effective in relaxing or fixing the animals in a state of really good extension.

Historical Review

Voigt (1904) published several accounts of the Gastrotricha of the waters of Plon. Among these was *Chaetonotus succinctus* n. sp., recovered from a small garden pool among *Utricularia* plants, in October and

November. Its total body length was 217-225 micra. Other measurements listed were:

Esophagus length	49.5 micra
Toe length	33 – 39 micra
Back spine length	78 micra
Lateral toe spine length	63 micra
Head width	39 micra

How many specimens he found or measured is not known, evidently more than one. The above records may represent, then, several to many individuals.

Konsuloff (1914) described the alleged species, obtained in April in Bulgaria, as "rare." His measurements were:

Animal length	193 micra
Esophagus length	41 micra
Head scale length	3.2 micra
Head spine length	4.8 micra
Back spine (rear) length	72 micra
Back scale (rear) length	3.4 micra
Head width	35.5 micra

No ranges are given here to indicate that more than one individual was studied for measurement.

Remane (1935-36), a recognized gastrotrichan authority, has supplied meager dsecriptions of *C. succinctus*. He placed it in the same group with *C. acanthodes* Stokes. Stokes (1918) was the early microscopist who discovered and described in New Jersey so many of our gastrotrichan forms. His brief description of *C. acanthodes* in the citation shows that there is rather close general similarity between it and *C. succinctus*. The most conspicuous feature of both is, perhaps, the mid-body circlet of very long spines which extend posteriorly around the animal like the ribs of a partly closed umbrella-half. Probably the major difference is the furcation of the recurved "body" spines observed by Stokes (l. c.) in *C. acanthodes*. Figures of *C. succinctus*, in Remane (l. c.) for example, have no forking of either short or long spines.

The figure by Stokes (l. c.) of the posterior portion of *C. acanthodes* lacks the transverse row of long spines. Those which are shown are unfurcated. There is no enlarged diagram of either short or long spines. Ward and Whipple (1918) reproduced the same figure, p. 627. The diagram shows no small, supplementary scale of the larger basal plate from which it is said the spine springs.

C. succinctus was seemingly next discovered by Saito (1937) in August and September in a *Lotus* pool in the vicinity of Hirosima. Among the measurements taken for an undetermined number of animals are those for total length, 226 micra, head width 39 micra, and toe length, 33 micra, exactly as Voigt (l. c.) found. None of these corresponds to those taken by Konsuloff (1914).

Brunson (1950), reporting on 18 species of gastrotrichs from Michigan, describes *C. trichostrichodes* n. sp. as ". . . the only species of *Chaetonotus* yet found that has its spines in a transverse band across the back." It would seem that he is referring to his own findings for he does not cite the work of Voigt, Konsuloff, nor Saito in this particular paper. The transverse row of spines of Brunson (l. c) is 5 in number, a "diagnostic" feature. They are unequally bifurcated ("singly barbed"), and ". . . the body covering appears scaled, but distinct individual scales were not seen ". The head is distinctly 5-lobed. The animal's dimensions are less than those for *C. acanthodes* as given by either Voigt (l. c.) or Stokes (l. c.). It is not stated how many of these animals were measured or observed. The species would appear to qualify for the "acanthodes" category. Pennak (1953) reproduces this drawing as "B," though "modified from Brunson, 1950," in a plate entitled "Structure of various species of *Chaetonotus.*" The spine bifurcations can be clearly seen though the species itself is undesignated.

Remane's (l. c.) brief characterization of *C. succinctus* mentions a "pharyngeal bulb," the very pointed spines with barbs, the escutcheon-like basal plates. Species of this group are said to be small to medium in size, inhabiting vegetation zones of fresh waters, especially in *Sphagnum* bogs.

Ashland specimens conformed closely to *C. succinctus*, in respect to descriptions and figures of external structure. Measurements were obtained for various parts with an ocular micrometer, on 5 specimens, which are shown in table I.

The measuring of gastrotrichs is difficult. Investigators, both here and abroad, include varying statistics on body parts in their studies. This is very likely due to the obstacles met in securing completely extended specimens; measurements of animals in the living state where they are rarely, if ever, wholly motionless; lack of sharply delineated landmarks for measurement; optical disadvantages to be overcome, and other factors. The animal may be prone, or seen laterally, or so placed that one body part may be seen from the dorsal position whereas another may be lateral or even dorso- or ventro-lateral. Gaps, therefore, in the above table occur because it was not always possible under existing conditions to obtain a reliable measurement.

Because an exact interpretation of measurements by the observers mentioned is impossible, a critical comparison of their findings with Ashland data is not too satisfactory. "Body length" with any of the 3 investigators could mean an overall measurement from front margin of head shield to posterior (distal) tip of toe, and probably does. Yet it might refer to the extent of the animal up to the midline point where the forked toes take origin. In the present study it is the former. Toe length, then, extends from distal tip forward to the trunk (rumpf) line level, with no easily determinable landmark line existing here for separation. Toe length is included, therefore, in the author's total, overall result.

There is variation in the measurements obtained for Ashland individuals. This is not too surprising inasmuch as a gastrotrich is hatched from the egg incompletely developed and comes to mature size as it feeds An average of the 3 overall size lengths gives a figure of 168.2 micra which is less than any of the 3 other observers found. Esophagus length is possibly a more uniformly constant one in a species. Here a local read-

	1	2	3	4	5
Long post. rump spine	49.9	43.2			
Long post. lat. spine		56.6		59.9	
Short shank spine			13.3		
Short body spine			19.9		33.3
Body circlet spine		49.9		56.6	
Esophagus length			63.2	49.9	43.2
Toe length	23.3	23.3		33.3	49.9
Overall body length			166.5	178.1	159.8
Head width				26.6	33.3
Neck width				26.6	26.6
Body width				43.2	46.6

Table I. Dimensions in micra of five specimens of a gastrotrich from Ashland, Virginia.

ing is the same as that of Voigt (l. c.). Another is only slightly more than one of Konsuloff (l. c.). The toe length of an Ashland form is the same as that recorded by Saito (l. c.).

Considered from various viewpoints the size differences between the local and European specimens are not so great as to rule out the conclusion that the species are very likely the same. However, Brunson (l. c.), who has done the most extensive recently published work on the gastrotrichs in the United States expresses an interesting viewpoint; he says ". . . no one worker has studied or compared gastrotrichs from both Europe and North America, and so it is not known whether cosmopolitanism occurs in this group." Yet Pennak (1955) described the assemblage as cosmopolitan with respect to genera and their freshwater distribution. Brunson (l. c.) resumes ". . . until European material can be studied the author is assuming that the same species do not occur in both continents." He does make exception in the case of *Lepidodermella squamata* Dujardin. He was, possibly, unaware that Voigt (l. c.) discovered *C. acanthodes* of Stokes (l. c.) in Germany, or so designated it, for example. Also there seem to be no reports of gastrotrichs described for any part of North America but the United States.

So far as is known to this investigator the position taken by Brunson (l. c.) is unique with respect to gastrotrichan species. The opposite point of view is illustrated for *C. succinctus* because it is reported from Germany, Bulgaria, and Japan. It is felt, therefore, in the present case that *Chaetonotus succinctus* Voigt, or at least a closely related variant, has been discovered in the United States and reported from Ashland, Virginia, for the first time, a species described by Konsuloff (l. c.) as "rare."

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A Procedure For Simultaneous Blood Volume Determinations Using Radioactive Phosphorus-32 And T-1824 (Evans Blue) Dye

Jack D. Burke[1]

Department of Biology, University of Richmond

There are only two ways in which blood volume can be determined in an animal: directly and indirectly. In the direct method, as introduced by Welcker (1858), a blood sample of known volume is withdrawn and diluted with normal saline solution. This dilute solution serves as a comparative sample. Then as much blood as possible is removed by bleeding and tissue washings. The collected blood is diluted with water to match the color of the comparative standard. This dilute volume, divided by the dilution ratio of the standard, serves as a measure of the total blood volume. This method is not free from inherent errors such as those pertaining to clotting and blood collection.

The first indirect method of blood volume studies was reported by Valentin (1838). He injected distilled water into the circulation of an animal, and compared the blood solids of a prepared standard with the diluted blood solids of a withdrawn sample. Although hemolysis induced large errors, a stimulus was provided for other investigators using this method. Such substances as serum (Malassez, 1875; Nelson, 1909), sodium chloride (Sherrington and Copeman, 1903; Kottman, 1906; Plesch, 1909), antitoxin (Von Behring, 1911), foreign serum (Schurer, 1911), gum acacia (Meek and Gasser, 1918; Robertson and Bock, 1919; McQuarrie and Davis, 1920), and hemoglobin (Lee and Whipple, 1921) were among other substances used for determining blood volumes indirectly. These substances, in general, were not acceptable because they induced errors quantitatively and/or qualitatively.

The vital red dye series of study was introduced by Keith *et al.* (1915) whereby the plasma was tagged. Results of this investigation led others such as Dawson *et al.* (1920), Harris (1920), Hooper *et al.*

[1] Time afforded for this study was made possible by a Post-Doctoral Research Fellowship of the American Physiological Society, sponsored by the National Heart Institute, National Institutes of Health, Bethesda, Md., in Dr. S. T. Hall's Physiology Laboratory, Duke University School of Medicine, Durham, N.C.

(1920), and Graff and Clark (1931) into a qualitative investigation of various vital dyes regarding blood volumes. However, Dawson *et al.* (l. c.) recognized the superiority of blue over red dyes in animal experimentation. Their American dye (Chicago blue 6 B) was obtained in England as chlorazol sky blue FF by Elliott *et al.* (1934) who used this blue dye (T-1854) for determining fetal blood volumes colorimetrically.

In 1935 Gregersen *et al.* reported on the success of T-1824 (Evans blue) dye in determining plasma volumes. The principal points favorable to this blue dye was that its absorption range was removed from that of hemoglobin so that colorimetric and spectroscopic analyses could be made without introduced hemolytic errors, nontoxicity (Gibson and Gregersen, 1935), small rate of exocirculatory diffusion and non-absorption by red blood corpuscles (Gregersen and Schiro, 1938).

Tagging red blood corpuscles was first reported by Grehant and Quinquand (1882) wherein carbon monoxide was utilized. The inherent errors here lie in intra-tissue diffusion and instrumental analyses as pointed out by Reeve (1948). Hahn and Hevesy (1940) reported their successful attempt of tagging red corpuscles with radiophosphorus-32. This isotope can be handled advantageously since it is not a gamma emitter, has a relatively short half-life of 14.3 days, and exchanges readily with organic phosphorus in red blood corpuscles.

Thus, a study of blood volume investigations reveals that either the plasma or the red blood corpuscles must be tagged in order for a substance, to remain in the blood circultaion long enough for sampling at time intervals. Therefore, calculated blood volumes are primarily delimited by quantitative and/or qualitative measurement. The chief factors related to blood volume delimitations are instrumentation, type of tagging substance, exocirculaotry diffusion, turn-over rate and/or steady state equilibrium, and toxicity.

The procedure described below is the same as that used by Burke *et al.* (1953), and by Burke (1954) in determining blood volumes in different mammals such as rabbits, opossums, dogs, racoons, and swine. In comparing the determined blood volume values obtained by the P-32 and T-1824 methods by statistical treatment (in opossums), it was found that no statistical difference existed. Furthermore, these two methods (as described in the procedure) are particularly suited for animals weighing from one to 250 lbs. Blood volume in smaller or larger animals may be determined by modifying the procedure so as to vary the concentration of the injection dose of dye or P-32 labeled corpuscles. In the main, this procedure has been modified from Hevesy *et al.* (1943), Gregersen (1944), and Nachman *et al.* (1950).

PROCEDURE

1. Withdraw approximately 10 ml. of blood by veni-puncture or cardiac stab (on anesthetized animals) into a greased, heparinized syringe affixed with a suitable hypodermic needle. Deposit the blood gently in a 15 ml. graduated hematocrit tube containing 0.1 ml. heparin (100 mg. dried heparin dissolved in 15 ml. physiological saline solution.)

2. Centrifuge the blood at 3000 rpm. for 30 minutes. Record the hematocrit.

3. Remove 2 ml. of plasma from the tube and precipitate the plasma proteins: use 1:7 ratio with precipitating reagent (mix 6 ml. of 15 gm. phosphortungstic acid dissolved in 100 ml. of 98% ethyl alcohol with 1 ml. of concentrated hydrochloric acid). Stir for 5 minutes, centrifuge at 3000 rpm. for 5 minutes and pour the supernatant into a Klett tube. Zero the optical density as read on a Klett-Summerson photoelectric colorimeter using a filter with a maximum transmission of light having a wave-length of 622.5 mmu. Refer to this reading as the ***blank***.

4. Make-up a *primary* T-1824 dye solution in physiological saline (1 to 4 mg/ml for animals weighing 1 to 100 kg.). Dilute 10 ml. of the primary solution to 100 ml. with distilled water. This serves as the *secondary* dye solution.

5. Add 0.2 ml. of the secondary dye solution to 1.8 ml. of plasma. Deproteinate this solution with the precipitating reagent as described in (3). Record the optical density of this dye *standard* solution (now diluted 100 times) as read on the colorimeter.

6. Wash the red blood corpuscles from (3) with iced, physiological saline solution 3 times and centrifuge at 3000 rpm. for 5 minutes; remove the supernatant with a suction pipette, and discard, after each washing.

7. Add isotonic P-32 solution, containing approximately 50 microcuries of activity, to the red blood corpuscles until the original volume of blood withdrawn in (1) is reached.

8. Incubate this suspension from 1 to 2 hours in a water bath at 37° C. Stir every 10 to 15 minutes with a small, glass rod.

9. Centrifuge the suspension at 3000 rpm. for 5 minutes. Remove and discard the supernatant. Wash the labeled corpuscles 3 times with iced, physiological saline and centrifuge at 3000 rpm. for 5 minutes after each washing; discard the supernatant each time.

10. Add physiological saline solution to the washed and labeled red blood corpuscles until the original volume of blood withdrawn in (1) is reached. Stir the suspension with a small, glass rod. Dilute an aliquot to a known volume with distilled water which serves as the P-32 *standard* solution.

11. Inject 5 ml. of the primary dye solution from (4) and 5 ml. of the labeled corpuscle supension from (10) into a jugular vein (or other vein depending on the animal). Rinse the syringe 2 or 3 times with blood before removing it from the vein.

12. Withdraw approximately 5 ml. of blood at intervals of 5, 10, and 15 minutes from the opposite (jugular) vein of that into which the injection was made. Use greased, heparinized syringes.

13. Place the withdrawn blood in graduated 15 ml. centrifuge tubes to which heparin has been added as in (1). Centrifuge each sample at 3000 rpm. for 30 minutes and record the hematocrit.

14. Remove the plasma carefully so as not to disturb the red blood corpuscles with a small pipette. Precipitate the plasma proteins of a 2 ml. sample as in (3). Record the optical density of each plasma sample as read on the colorimeter. Calculate the total plasma volume and total blood volume as shown in (18).

15. Wash the red blood corpuscles from (14) according to the procedure in (9).

16. Dilute the labeled corpuscles of each sample to volume with distilled water.

17. Count and record the activity of the P-32 standard and labeled corpuscle samples, singly, using a convenient scaler with an immersion-type Geiger-Muller tube and appropriate aliquots. Calculate the total blood volume and total red cell volume as shown in (19).

18. $V_s = \dfrac{100 \times D_1 \times V_1}{D_2}$

100 = the dilution factor determined in (4) and (5).
D_1 = the optical density of the plasma standard dye solution
D_2 = the optical density of the plasma sample dye solution
V_1 = the volume of the primary dye solution injected
V_s = the total plasma volume

$$\text{*Hematocrit red corpuscle value} = \frac{\text{red corpuscle volume of hematocrit}}{\text{whole blood volume of hematocrit}}$$

Hematocrit plasma value = (1 - corrected hematocrit red corpuscle value)

$$\text{Total blood volume} = \frac{\text{total plasma volume}}{\text{hematocrit plasma value}}$$

19. P-32 calculations:

$$V_2 = \frac{V_1 \times S_1}{S_2}$$

S_1 = the counts per minute of the injection dose
S_2 = the counts per minute of the blood sample
V_1 = the volume of the blood sample
V_2 = the total blood volume

$$\text{Red corpuscle volume} = \frac{\text{HRCV} \times 0.915 \times \text{c/m I. D.}}{\text{c/m sample}}$$

HRCV = the hematocrit red corpuscle volume
c/m I. D. = the counts per minute of the injection dose
c/m sample = the counts per minute of the sample

ACKNOWLEDGMENTS

Appreciation is expressed to Dr. H. B. Sherman, Professor Emeritus, Department of Biology, University of Florida, Gainesville; Dr. Ray L. Shirley, Biochemist, and Dr. George K. Davis, Director, Nutrition Laboratory, University of Florida for their aid and critical evaluations in helping to develop this technique for blood volume determinations. Dr. F. G. Hall, Chairman of the Department of Physiology and Pharmacology, Duke University School of Medicine, Durham, N. C. kindly offered advice and comments on the paper.

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News And Notes

(Editor's Note: News contributions should be sent to the person whose name appears at the end of the appropriate sections.)

MINUTES OF THE FINANCE AND ENDOWMENT COMMITTEE MEETING

Richmond, Virginia — February 20, 1958

The Finance and Endowment Committee met on February 20, 1958, at the Commonwealth Club with the following members present:

Guy Horsley, *Chairman*	Boyd Harshbarger
John Forbes	Robert Smart
Edwin Cox	Foley Smith
William Guy	William Wartman

The chairman distributed copies of the proposed 1958 budget and a report of the estimated 1958 income. He pointed out that the estimated income just about equalled the 1958 budget and, as a consequence, any increase in the budget would require additional income or use of reserve funds.

The treasurer reported that a number of members were upgrading their memberships, most of these being from regular to contributing members.

The chairman expressed the feeling that increasing business memberships was the most likely means of securing additional income. Dr. Forbes suggested that the Academy might consider having a fifty-dollar associate business membership in addition to the regular business membership.

The treasurer distributed copies of the auditor's report of the Academy funds for the two-year period ending December 31, 1957. The estimated cost of this report is three hundred and twenty-five dollars (no statement has been received to date).

The items in the proposed budget were reviwed and the annual meeting expense was raised to seven hundred dollars. This resulted in the budget slightly exceeding the estimated income for 1958.

The chairman read excerpts from a letter from Robert Brumfield, editor of the Journal, in which the steadily rising costs of printing ex-

penses of the Journal were pointed out. This has resulted in the necessity of using reserve Journal funds.

Edwin Cox moved that, subject to approval of Council, the chairman of this committee appoint a subcommittee to raise fifteen hundred dollars during the calendar year. The motion was passed.

It was agreed that Council should be informed at its next meeting of the necessity of the Academy securing additional income.

W. B. Wartman, Jr.
Asst. Secretary

AGRICULTURE

Professor Paul M. Reaves, Department of Dairy Science, Virginia Polytechnic Institute received the 1958 Honors Award of the Southern Division, A.D.S.A. at its annual meeting in Little Rock, Arkansas, February 4, 1958. This award was based on Professor Reaves' outstanding contributions to the Dairy Industry of the South.

The second Dairy Science Career Day was held at Virginia Polytechnic Institute on March 3, 1958. This is a part of student recruitment program sponsored by the Virginia Dairy Products Association, the Virginia State Dairymen's Association, the Department of Dairy Science, Virginia Polytechnic Institute. Approximately 100 high school students and 35 industrial leaders who act as sponsors were in attendance.

The National Institute of Health has awarded a four-year research grant to Dr. D. G. Cochran, Associate Professor of Entomology, and Dr. K. W. King, Associate Professor of Bacteriology, to study "Oxidative phosphorylation in insect muscle mitochrondia." The grant for the first year is $7,668.00.

J. A. Schad, Professor of Industrial Arts Education, served as a representative of Virginia Polytechnic Institute on a three-man commission of the Roanoke Chamber of Commerce to study and present data on technical institutes. The report, entitled "A Technical Institute in Roanoke to Serve Western Virginia" was used as a source of information in presenting a proposal for legislative support in the 1958 session of the General Assembly.

Professor of Agricultural Education, Dr. T. J. Horne, is Chairman of the National Research Committee for Agricultural Education. At a recent meeting in Washington, he made a report of progress and participated in planning for an extensive research program in this field.

Carl J. Arnold, Associate Professor in the Department of Agricultural Economics, Virginia Polytechnic Institute has changed from full time extension work in milk marketing to full time research in Agricultural Policy with the Virginia Agricultural Experiment Station.

Dr. A. J. Walrath, Agricultural Economist with the Agricultural Research Service, is now working with the Agricultural Economics Department, Virginia Polytechnic Institute on "Adjustments in land use areas where new employment opportunities are created."

Dr. John McNeall Sieburth, Associate Professor of Bacteriology at the Virginia Polytechnic Institute, has just returned from a visit to the South Pole as a guest of the Argentine Navy. His trip was sponsored by the Arctic Institute of North America, the Virginia Polytechnic Institute, and the Hydrographic Service of the Argentine Navy. He made microbiological studies of Antartic birds to determine the incidence of diseases transmissible to man and the reasons for previous findings of bacteria free conditions in certain Antartic birds.

— Carl W. Allen, *Virginia Polytechnic Institute.*

BACTERIOLOGY

Dr. E. Clifford Nelson attended the meetings of the American Society of Tropical Medicine and Hygiene of the American Society of Parasitologists in Philadelphia, October 30-November 2, 1957.

Dr. Holmes T. Knighton, Professor of Dentistry and Bacteriology, attended and participated in the conference of the American Dental Association Council on Dental Therapeutics held in Chicago February 14 and 15.

A paper on the "Influence of Inflammatory Reactions on Localization of Blood-Borne Bacteria" was presented by Dr. Holmes T. Knighton and Dr. George W. Burke at the meeting of the International Association for Dental Research held in Detroit, March 20-22.

—P. Arne Hansen, *Department of Microbiology, University of Maryland*

BIOLOGY

A new organization "The Herpetological Society of Virginia" is being formed. All interested persons are asked to contact the Acting Secretary, Franklin Tobey, Route 2, Box 485, McLean, Virginia. Objectives of the society are (1) Scientific study of the Commonwealth's hepetofauna; (2) Improvement in the quality of reporting occurrence of species; (3) Encourage county surveys and exchange of such verified data; (4)

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The Biology Department of the University of Virginia sponsored a rather full program of guest speakers and conferences for the winter and spring, 1958. Among the guest speakers were Dr. John Buck of the National Institutes of Health; Dr. William H. Weston of Harvard; Dr. Caroll Williams of Harvard; Dr. Tom Hall of Washington University; Dr. Nelson Spratt of International Science Foundation; and Dr. Oswald Tippo of Yale University.

Dr. J. D. Burke of the University of Richmond has received a grant from the National Institutes of Health for the purchase of special equipment to continue his study of oxyhaemoglobin in fish.

—Walter S. Flory, Jr., *Blandy Experimental Farm, University of Virginia*

CHEMISTRY

The services of Richard M. Irby, Jr., Senior Research Associate for the American Tobacco Company, have been donated to the Richmond school system on a part-time basis. Dr. Irby will teach a twenty-student class at Thomas Jefferson High School in conjunction with Miss Virginia C. Ellett, a member of the high school science faculty. The course will be on a first-year college-level basis and is part of the advanced placement program which prepares students to gain credit and advanced standing in college for work completed in high school.

—Merle A. Kise, *Virginia Smelting Company*

ENGINEERING

Professor Frank C. Vilbrandt of the Chemical Engineering Department of Virginia Polytechnic Institute accompanied graduate students of this department on a visit to the DuPont plant at Parkersburg, West Virginia in November. Professor Nelson F. Murphy, also in the Chemical Engineering Department at the Virginia Polytechnic Institute, was co-author of a paper entitled "Correlation of Interfacial Tensions of Three-component Liquid Systems" which appeared in the June issue of *Industrial and Engineering Chemistry*. Dr. Murphy attended the Gordon Research Conference on the application of statistics to chemistry and chemical engineering. In February, he attended the regional meeting of the American Electroplaters' Society in Atlanta, Georgia, serving as chairman

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of one session. Dr. Murphy was one of two inventors to whom a United States patent on a method of electroplating aluminum was issued in September.

Mr. Tilton E. Shelburne, director of the Virginia Council for Highway Investigation and Research at the Universtiy of Virginia, in his capactiy of District Six Director of the American Society of Civil Engineers, attended a meeting of the Pittsburg Section of this society in January. In January and February, he attended meetings of the Special Technical Advisory Panel on Performances Rating of the AASHO Road Test which were held in Washington and Chicago. Mr. James L. Eades, also of the Virginia Council For Highway Investigation and Research, attended a meeting of the Highway Research Board in Washington in January as a member of the Sub-Committee on Soil Stabilization.

Engineering Dean Lawrence R. Quarles of the University of Virginia has been appointed chairman of the Committee on Advanced Training in Engineering and Applied Science by the Virginia Council on Higher Education. Dean Quarles has announced that all negotiations have been completed for the construction of the one-megawatt nuclear reactor at the University of Virginia. The National Science Foundation awarded a grant of $150,000 for this reactor and the Atomic Energy Commission provided $19,000 for instruments for the nuclear laboratory.

Professor Orville R. Harris, Director of the University of Virginia Engineering Experiment Station, and Professor Otis L. Updike of the Chemical Engineering Department of the University attended the Eastern Joint Computer Conference in Washington in December. Dr. Updike was a member of the Local Arrangements Committee for this meeting and is a member of the Steering Committee of the Eastern Simulation Council which was one of the sponsors of this meeting. Professor Robert M. Hubbard of the Chemical Engineering Department of the University of Virginia attended the annual meeting of the American Institute of Chemical Engineers in Chicago in December.

— Robert M. Hubbard, *University of Virginia*

GEOLOGY

B. N. Cooper was elected Vice President of the American Association for the Advancement of Science and Chairman of Section E (Geology and Geography) at the meeting of the Association on December 29, 1957.

R. V. Dietrich's paper on "Chromian Muscovite from Baker Mountain, Virginia" appeared in *The American Mineralogist*, 43: (1 and 2),

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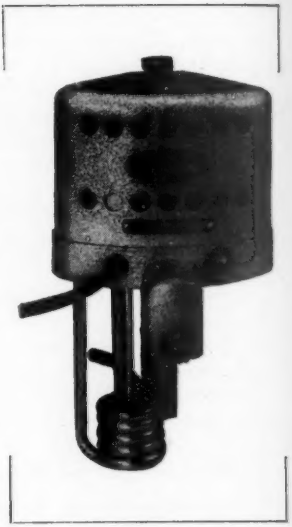

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There are no fragile glass components in this control system, and no electronic tubes to replace. Pneumatic control is inherently safe. If damage is done to the circulating system, or if overheating should occur, the controlling diaphragm collapses and the heater is switched off.

CAN CIRCULATE 1 LITER PER MINUTE to external instruments such as refractometers and viscosimeters while closely controlling on uninsulated 4-gallon water bath. The 6-bladed stirrer produces the circulation.

STIRRER HAS NO SUBMERGED BEARINGS: Vertical mounting of the motor reduces to a negligible value the load upon its bearings, which are oil-impregnated. The shaded pole, 1/20-HP motor is brushless and fan-cooled. It is constructed for continuous operation of the stirrer. For 115 volts, 60 cycles AC.

1,000-WATT IMMERSION HEATER is of the tubular type wound in the shape of a helix. The stirrer rotating inside the heating coil effectively dissipates heat. A magnesium oxide coating makes the heater capable of operating at temperatures far above the range of the Tempunit. Large capacity of the heater enables rapid heating of water bath from room temperature to set point without excessive overshoot.

EASILY ATTACHED TO ANY CONTAINER, small or large, by fiber-cushioned clamp. Weight of the Tempunit is only 6¼ lbs., and its overall length is only 10 inches. Case dimensions are 5½ x 4½ x 3½ inches.

No. RE414-60 TEMPUNIT, each $135.00

LAPINE ARTHUR S. LaPINE and COMPANY 6001 SOUTH KNOX AVENUE CHICAGO 29, ILLINOIS, U.S.A.

LABORATORY SUPPLIES • EQUIPMENT • REAGENT AND INDUSTRIAL CHEMICALS

1958. The second edition of "Virginia Minerals and Rocks" by R. V. Dietrich is now available. It was reprinted as Bulletin 122 of the Virginia Engineering Experiment Station.

James L. Calver and E. O. Gooch attended the annual meeting of the American Institute of Mining, Metallurgical, and Petroleum Engineers held in New York City on February 17-20. Dr. Gooch's paper entitled "Infolded Metasediments Near the Axial Zone of the Catoctin Mountain-Blue Ridge Anticlinorium" is to appear in the April issue of the *Bulletin of the Geological Society of America.*

Donald C. Le Van joined the staff of the Virginia Division of Mineral Resources on December 16, 1957. He received his Bachelor's and Master's Degrees from the University of Michigan. Before joining the staff he was employed by the Pan American Petroleum Corporation. He is married and has one son.

H. R. Hopkins is on educational leave from the Virginia Division of Mineral Resources and is working toward a doctorate in geology. He will return to full-time employment for the summer field season of 1958. Robert S. Wood joined the permanent staff of the Division on August 16, 1957. He received his Bachelor's degree from Washington and Lee University and is doing graduate work at the University of Virginia.

—W. D. Lowry, *Virginia Polytechnic Institute*

PSYCHOLOGY

Frank W. Finger is now a representative of the American Psychological Association on the AAAS Council. Richard H. Henneman is representing the Southern Society for Philosophy and Psychology on the AAAS Council.

Richard H. Henneman represented the University of Virginia (in place of Dr. F. A. Geldard, departmental chairman) at a meeting of the heads of departments of psychology granting Ph. D. degrees, which was sponsored by the Southern Regional Education Board and held in Atlanta, December 1-3, 1957.

L. Starling Reid has bene appointed a consulting editor of the Journal of Experimental Psychology.

Frank A. Geldard has been reappointed to the Divisional Committee on Biology and Medicine of the National Science Foundation.

Hollins College will introduce a co-educational Master of Arts program in the Fall of 1958.

The following speakers are part of the Hollins College Psychology Club program for 1957-58: Fred Keller, B. J. Underwood, Michael Scriven, George Wischner, Carl Frost, Marvin Dunnete, Albert Canfield, Frank Geldard, Murray Sidman, Janet Taylor, and Corbett Thigpen.

Current Studies in Psychology, Appleton-Century-Crofts, by F. J. McGuigan and Allen D. Calvin will appear this Spring.

Dr. Cyril Mill recently resigned his position as Clinical Psychologist with the Children's Division of the Allentown, Pennsylvania State Hospital, to accept the position of Chief Clinical Psychologist for the Virginia State Department of Mental Hygiene. He assumed his duties on February 1.

On February 28 the Richmond Psychological Association co-sponsored a panel program entitled "Modern Approaches to the Retarded Child." Included in the panel was Robert Gibby, Chief Clinical Psychologist, McGuire VA Hospital. William L. Dunn, Jr., Vice-President of the Richmond Psychological Association, served as moderator.

—John K. Bare, *College of William and Mary*

STATISTICS

Prof. Boyd Harshbarger attended the AAAS meetings in Indianapolis where he presided over the session on the Relation between Smoking and Lung Cancer. The speaker for this occasion was Sir Ronald A. Fisher, Cambridge, England. The session was attended by over 700.

Dr. Herbert A. David is now with the Department of Statistics at the Virginia Polytechnic Institute. Dr. David was born in Berlin and attended schools in Dusseldorf, Germany and Sydney, Australia. He received the B.Sc. in mathematics from the University of Sydney and the Ph.D. in statistics from the University of London. He was senior lecturer at the University of Australia prior to his joining the Department of Statistics at the Virginia Polytechnic Institute. He has written a number of papers on mathematical and applied statistics, many of which were published in *Biometrika*.

Dr. Rolf Bargmann joined the Department of Statistics at the Virginia Polytechnic Institute in January. He was born in Germany and received his formal education from the University of Berlin, University of Hamburg, University of Chicago, and completed the requirements for the doctorate at the University of North Carolina in December 1957. Dr. Bargmann's duties have included working as a designer of radio equipment and chemist; part-time instructor for physics, mathematics,

and English at Hamburg; court interpreter for English and German at the Nuernberg Trials; "Textbook Analyst" for the evaluation of German textbooks in mathematics, science, and foreign languages; Consultant for Educational Research; Research Assistant, Assistant Professor and Chief of Statistical Department, Hochschule fuer Internationale Paedagogische Forschung, Frankfurt, Germany.

Norbert Lloyd Enrick, Head of Statistics, Institute of Textile Technology, Charlottesville, Virginia, attended the convention of Committee D-13 of the American Society for Testing Materials, Subcommitte B-8, to continue his work with the Task Group on Electronic Yarn Imperfection Counters; and to work further with Subcommittee B-5 in preparing an ASTM manual of statistical methods for textile technologists.

—Clyde Y. Kramer, *Virginia Polytechnic Institute*

Virginia Academy of Science

Program

OF THE

Thirty-Sixth Annual Meeting

AT HOTEL ROANOKE

ROANOKE, VIRGINIA

May 7, 8, 9, 10, 1958

HOSTS TO MEETING

HOLLINS COLLEGE

ROANOKE COLLEGE

VIRGINIA POLYTECHNIC INSTITUTE

AMERICAN VISCOSE CORPORATION

GENERAL ELECTRIC COMPANY

NORFOLK AND WESTERN RAILWAY COMPANY

VETERANS ADMINISTRATION HOSPITAL

Virginia Academy of Science

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John C. Forbes, *President-Elect*
Paul M. Patterson, *Secretary*
Foley F. Smith, *Treasurer*
William B. Wartman, *Assistant Secretary-Treasurer*

COUNCIL

(Board of Trustees)

Elected Members

Byron H. Cooper (1958)
William M. Hinton (1959)
Mrs. B. G. Heatwole (1960)
Thomas E. Gilmer (1961)
Horton H. Hobbs, Jr., (1962)

Ex-Officio Members

Irving G. Foster (1958)
Walter S. Flory (1959)
Edward S. Harlow (1960)
Lynn D. Abbott, Jr.
Robert T. Brumfield
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LOCAL COMMITTEE ON ARRANGEMENTS

BOYD HARSHBARGER (Virginia Polytechnic Institute), *General Chairman*

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PAUL M. PATTERSON (Hollins College) and RALPH A. BRADLEY (Virginia Polytechnic Institute), *Meeting Rooms and Equipment*

ASHLEY ROBEY (Roanoke College) and MISS LESLIE WATKINS, *Junior Academy Exhibits*

H. L. HOLLOWAY (Roanoke College), N. F. MURPHY (Virginia Polytechnic Institute), and R. W. ENGLE (Virginia Polytechnic Institute), *Registration*

R. E. GARRETT (Hollins College) and MISS LESLIE WATKINS, *Public Information*

N. F. MURPHY (Virginia Polytechnic Institute), J. D. SCHUMACHER

(American Viscose Corporation, B. W. MAHONEY (General Electric Company) and G. V. DOWNING (Leas and McVitty, Inc.), *Commercial Exhibits*

P. R. THOMSON (General Electric Company), B. M. SMITH (Veterans Administration Hospital), and R. A. CRAIGHEAD (Norfolk and Western Railway Company), *Industrial Tours.*

MRS. RUTH PAINTER (William Fleming High School), MRS. ATHENA BURTON (Roanoke College), and DOROTHY D. MONTGOMERY (Hollins College), *Entertainment for Ladies*

HOSTS TO MEETING

HOLLINS COLLEGE

ROANOKE COLLEGE

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General Program Of The 36th Annual Meeting

All meetings, unless otherwise indicated, will be held at the Hotel Roanoke, Roanoke, Virginia

EXHIBITORS. PEACOCK ALLEY

WEDNESDAY, MAY 7

5:00 P.M. to 10:00 P.M.—Registration for Junior Academy Members and Participants in the Science Talent Search. Colonial Room.

5:00 P.M. to 10:00 P.M.—Arrangement of Exhibits. Exhibit Room (in basement).

THURSDAY, MAY 8

8:00 A.M. to 10:00 P.M.—Registration. Colonial Room.

9:00 A.M.—Meeting of Science Exhibit Judges. Parlor L.
Meeting of Science Talent Search Judges. Parlor K.

9:30 A.M.—Meeting of Chairmen, Exhibitors, and Science Talent Search Participants, Shenandoah Room.

10:00 A.M. to 12:30 P.M. and 1:30 to 4:00 P.M.—Finalists of Talent Search Meet with Chairmen and Interviewers. Parlors E, F, K, and L.

10:00 A.M. to 12:30 P.M. and 1:30 to 4:00 P.M.—Judging of Science Exhibit Contest. (Encouragement of Juniors at their Exhibits.) Exhibit Room.

2:00 P.M.—Meeting of the Council. Parlor D.

4:00 P.M.—Meeting of Section Officers, Pocahontas Room.
Meeting of Junior Academy of Science Committee. Parlor L.

4:30 P.M.—Meeting of Section Editors. Cavalier Room.

8:00 P.M.—Annual Academy Conference. Ballroom.

FRIDAY, MAY 9

8:30 A.M. to 10:00 P.M.—Registration. Colonial Room.

9:00 A.M.—Section Meetings. See the detailed section programs for the time schedule of papers.
Agricultural Science — Auditorium, St. Andrews School
Astronomy, Mathematics, and Physics — Parlor D
Bacteriology — Parlor L.
Biology — Shenandoah Room
Chemistry — Ballroom
Education — Parlor K
Engineering — Parlor E
Geology — Parlor F
Medical Sciences — Cavalier Room
Psychology — Pocahontas Room
Science Teachers — Pine Room
Statistics — Writing Room

12:00 Noon to 2:00 P.M.—Virginia Junior Academy of Science Assembly. Ballroom. (See Program of Junior Academy.)

1:00 P.M. to 2:00 P.M.—Recess for Luncheon.

2:00 P.M.—Section Meetings.

4:00 P.M. to 5:00 P.M.—Informal Tea and Fashion Show for Visiting Ladies. Laurel Room — Heironimus of Roanoke.

5:00 P.M. to 7:45 P.M.—Recess for Dinner.

7:45 P.M.—Virginia Academy of Science Assembly. Ballroom.
Welcome from Hosts to the Meeting by Boyd Harshbarger. Short Business Meeting. Election of Officers. Presentation of Presentation of the J. Shelton Horsley Research Award.
Guest Speaker: Dr. Laurence H. Snyder, Dean of the Graduate College, University of Oklahoma, and Immediate Past President of the American Association for the Advancement of Science.
Subject: Heredity in Human Health and Disease.
The general public is invited to attend.

SATURDAY, MAY 10

9:00 A.M.—Section Meetings.
10:00 A.M.—Meeting of the Council of the Academy. Parlor D.

Program Of The Virginia Junior Academy Of Science

All meetings will be held at the Hotel Roanoke, Roanoke, Virginia

WEDNESDAY, MAY 7

5:00 P.M. to 10:00 P.M. — Registration for Junior Academy Members and participants in the Science Talent Search. Colonial Room

5:00 P.M. to 10:00 P.M. — Arrangement of Exhibits. Exhibit Room (basement)

THURSDAY, MAY 8

8:00 A.M. to 10:00 P.M. — Registration. Colonial Room

9:00 A.M. to 9:30 A.M. — Meeting of Science Exhibit Judges. Parlor L
Meeting of Talent Search Judges. Parlor K

9:30 A.M. to 10:00 A.M. — Meeting of Chairmen, Exhibitors, and Science Talent Search Participants. Shenandoah Room

10:00 A.M. to 12:00 P.M. — and 1:00 P.M. to 3:00 P.M. — Finalists of Talent Search meet with Chairmen and Interviewers. Parlors E, F, K, and L

10:00 A.M. to 12:00 P.M. — and 1:00 P.M. to 3:00 P.M. — Judging of Science Exhibit Contest. Exhibit Room

3:00 P.M. — Business Meeting of Virginia Junior Academy of Science. Parlor L

8:00 P.M. —Discussion Hour: Junior Academy Members and Invited Scientists.

FRIDAY, MAY 9

9:00 A.M. — Participation in the Senior Academy Section Meetings.

12:00 Noon to 2:00 P.M. — Virginia Academy of Science Assembly and Awards Hour. Ballroom
Guest Speaker: To be announced.

Section Of Agricultural Science

James W. Midyette, Jr., *Chairman*

Allen H. Allison, *Vice-Chairman*

S. S. Obenshain, *Secretary*

C. W. Allen, *Section Editor*

FRIDAY, MAY 9—8:30 A.M.—AUDITORIUM, ST. ANDREWS SCHOOL

1. 8:30 Call to order by Chairman. Announcements and Committee Appointments.

2. 8:40 Available Calcium and Magnesium in Soils of Varying Texture.
W. W. Moschler; *Virginia Agricultural Experiment Station*

3. 8:55 The Affect of Initial Weight and Age upon the Molybdenum Induced Rat Growth.
Lynn Brinkman and R. F. Miller; *Virginia Agricultural Experiment Station*

4. 9:10 The Effect of Twelve Essential Elements Sprayed on Virginia Type Runner Peanuts at Flowering Stage.
D. L. Hallock; *Virginia Agricultural Experiment Station*

5. 9:25 Shift in Nitrogen Metabolism during the Life of a Cell.
R. R. Schmidt, R. W. Krauss, and K. W. King; *Virginia Agricultural Experiment Station*

6. 9:40 The Effects of Gonadotropins and other Hormones on the Various Reproductive Phenomena of the Ewe.
J. W. Gossett, B. Baker, P. P. Grayson, C. S. Givens, Jr., and R. C. Carter; *Virginia Agricultural Experiment Station*

9:55 Recess

7. 10:05 The Effect of Calcium, Phosphorus, and Copper upon the Growth of the Rat.
R. F. Miller; *Virginia Agricultural Experiment Station*

8. 10:20 New Crop Pests Threatening Virginia.
C. R. Willey; *Department of Agriculture and Immigration*

9. 10:35 The Use of Tetrazolium to Evaluate the Viability of Seed Peanuts.

H. L. Smith and T. G. Copeland; *Virginia Department of Agriculture*

10. 10:50 Regulating Fertilizer Pesticides Mixtures.
Maurice B. Rowe, III; *Virginia Department of Agriculture*

11. 11:05 *Guest Speaker*: R. W. Engel, *Virginia Agricultural Experment Station*
Subject: Higher Education in the Sciences in Virginia.

12. 11:35 Resources Needed in Virginia Agriculture in the Decade Ahead.
C. W. Allen; *Virginia Agricultural Experiment Station*

11:50 Adjourn for Lunch.

13. 1:15 Use of Infra-Red for Conducting Regulatory Chemical Analyses.
Boyd L. Samuel; *Virginia Department of Agriculture*

14. 1:30 *Guest Speaker*: V. H. Young, Jr., *Merck & Co., Inc.*
Subject: History and Potential Use of Gibberellic Acid.

15. 2:00 Effect of Amino Acids in the Ration and Growth Pattern on Muscle Development In Swine.
C. C. Brooks and H. R. Thomas; *Virginia Polytechnic Institute*

16. 2:15 Checking Variety Claims on Oats, Barley and Soybeans by Laboratory And Field Tests.
Harry Smith, Graham Copeland, and J. W. Midyette, Jr.; *Virginia Department of Agriculture and Immigration*

17. 2:30 The Influence of Age, Sex and Season of Birth of Calf, and Age of Cow on Preweaning Growth Rate and Type Score of Beef Calves.
T. J. Marlowe, and J. A. Gaines; *Virginia Agricultural Experiment Station*

2:45 Recess

18. 2:55 Use of Soil Type in Appraisal Work in Fairfax County, Virginia.
C. S. Coleman; *Virginia Agricultural Experiment Station*

19. 3:10 Some Factors affecting the Optical Density of Acetone Extracts of Fresh Feces.
C. G. Noblitt and W. A. Hardison; *Virginia Agricultural Experiment Station*

20. 3:25 Cost of Packing Apples in Bushel Units as affected by Different Types of Equipment and the Scale of Operation.
Albert W. Graybill; *Virginia Agricultural Experiment Station*

21. 3:40 Effect of Lime on the Mineral Composition of Soybean Foliage.
N. O. Price, W. W. Moschler, and W. Kroontje; *Virginia Agricultural Experiment Station*

3:45 Business Session

Section of Astronomy, Mathematics and Physics

E. R. Dyer, Jr., *Chairman*

J. J. Taylor, *Secretary*

I. G. Foster, *Section Editor*

FRIDAY, MAY 9 — 9:00 A.M. — PARLOR D

9:00 Announcements

1. 9:10 Design and Evaluation of a Cadmium Shield on the Virginia Polytechnic Institute Exponential Pile.
A. DeVolpi and A. Robeson; *Virginia Polytechnic Institute*

2. 9:25 A Versatile, Flexible Control Rod for Sub-Critical Systems.
J. E. Kinzer and A. Robeson; *Virginia Polytechnic Institute*

3. 9:40 A Graphite Sigma-Pile for the Measurement of Moderate Parameters.
L. S. Anthony and A. Robeson; *Virginia Polytechnic Institute*

4. 9:55 The Vibrations of a Loaded Cantilever.
I. G. Foster; *Virginia Military Institute*

5. 10:10 Measurements of Compressibilities of Solidified Gases at Various Low Temperatures.
John W. Stewart and Ralph I. LaRock; *University of Virginia*

6. 10:30 Experimental Determination of the Densities of Several Solidified Gases at 77°K.
Ralph I. LaRock and John W. Stewart; *University of Virginia.*

7. 10:45 Rolling Polygons.
Robert C. Yates; *College of William and Mary*

8. 11:05 Colors, Magnitudes and Motions of Stars of Spectral Class R.
Gordon L. Vandervort; *University of Virginia* (Introduced by A. N. Vyssotsky)

9. 11:20 A Search for Distant Blue Stars in High Galactic Latitudes,
Charles R. Cowley; *University of Virginia* (Introduced by A. N. Vyssotsky)

10. 11:35 The Richmond Area Seminar for High School Mathematics Teachers.
E. Sherman Grable; *University of Richmond*

11:50 Business Meeting

12:00–2:00 Lunch and Junior Academy Program

11. 2:00 Long-Enduring Meteor Trains and Fireball Orbits (Third Paper).
Charles P. Olivier; *University of Pennsylvania*

12. 2:15 An Undergraduate Laboratory Course in Nuclear Physics.
Frederick R. Crownfield, Jr.; *College of William and Mary*

13. 2:30 Some Gamma Ray Experiments for an Undergraduate Course in Nuclear Physics.
E. T. Gerry and F. R. Crownfield, Jr.; *College of William and Mary*

14. 2:45 Experiments with the Ballistics of a Rifle Bullet.
S. Topp; *College of William and Mary* (Introduced by F. R. Crownfield)

15. 3:00 Design and Construction of a Long Lens Beta Ray Spectrometer.
J. W. Little and J. F. Roach; *College of William and Mary* (Introduced by F. R. Crownfield, Jr.)

16. 3:15 Comments on Magnetic Thin Films.
G. Wayne Clark; *Virginia Institute for Scientific Research*

17. 3:30 Hysteresis Loop Tracer for Magnetic Thin Films.
B. W. Sloope; *University of Richmond* (work done at Virginia Institute for Scientific Research).

18. 3:45 Magnetic Domains of Thin Films by the Kerr Magneto-Optic Effect.

Calvin O. Tiller; *Virginia Institute for Scientific Research*

19. 4:00 Coercive Force *vs.* Thickness for Thin Films of Nickle-Iron
Calvin O. Tiller and G. Wayne Clark; *Virginia Institute for Scientific Research*

20. 4:15 What Should We Do about Centrifugal Force and Earth Satellites?
B. W. Sloope; *University of Richmond*

SATURDAY, MAY 10

9:00 Announcements

21. 9:05 Pharmatomity — Atoms for Peace.
Mrs. Agnes K. Beall; *Rutgers University* (Introduced by Miss Elinor Wayne)

22. 9:25 The Quantum Theoretical Concept of Measurement.
John L. McKnight; *College of William and Mary*

23. 9:50 Millimicrosecond Pulse Amplifiers.
W. T. Joyner; *Hampden-Sydney College* (Introduced by T. E. Gilmer)

24. 10:05 A Relaxed Condition on the Existence Theorem for Simultaneous Implicit Functions.
Reuben R. McDaniel; *Virginia State College*

25. 10:20 A Further Study on Newton's Interference Patterns from Coated Surfaces.
H. Y. Loh; *Virginia Polytechnic Institute*

26. 10:35 On the Mechanical Properties of Whiskers of Hexagonal Metals.
P. B. Price and M. J. Skove; *University of Virginia*

27. 10:50 The Effect of High Strain and Low Temperature on the Resistivity of Metal Whiskers.
Herman H. Hobbs and E. P. Stillwell, Jr.; *University of Virginia*

28. 11:05 Photodisintegration of Light Nuclei.
P. Flournoy, R. S. Tickle, and W. D. Whitehead; *University of Virginia*

29. 11:20 The Al^{27}(gamma, 2P) Na^{25} to 65 Mev.
L. B. Aull and W. D. Whitehead; *University of Virginia*

11:50 Announcements and Adjournment

Section of Bacteriology

Mrs. Barbara H. Caminita, *President*

Miles E. Hench, *Vice-President*

Quentin N. Myrvik, *Secretary-Treasurer*

P. Arne Hansen, *Section Editor*

FRIDAY, MAY 9 – 11:00 A.M. – PARLOR L

11:00 Business Meeting

1. 2:00 Serum Bactericidin Levels for *Bacillus subtilis* in Human Malignancies.
   H. C. Alexander and Eva Soto-Figueroa; *Department of Microbiology, University of Virginia School of Medicine*

2. 2:15 Rapid Detection of *Salmonella typhosa* by Fluorescent Antibody Technique.
   Walter R. Dowdle, Charles T. Hall and P. Arne Hansen; *Department of Microbiology, University of Maryland*

3. 2:30 Studies on Human Tissue Antigens.
   Gerald Goldstein and Quentin N. Myrvik; *Department of Microbiology, University of Virginia School of Medicine*

4. 2:45 A Serological and Physiological Study of Heterofermentative Lactobacilli.
   Anne Zerschling and P. Arne Hansen; *Department of Microbiology, University of Maryland*

5. 3:00 Lysis of Modified Erythrocytes by Normal Serum.
   H. J. Welshimer and Nancy G. Winglewish; *Department of Microbiology, Medical College of Virginia*

6. 3:15 Methods for Revealing Ingested Bacteria in *Entamoeba histolytica.*
   E. Clifford Nelson; *Department of Microbiology, Medical College of Virginia*

7. 3:30 A Microbiological Study of Antarctic Birds.
   John McNeill Sieburth; *Virginia Polytechnic Institute*

Section of Biology

William J. Hargis, Jr.; *Chairman*

Bertram L. Hanna, *Secretary*

Walter S. Flory, Jr.; *Section Editor*

FRIDAY, MAY 9 — 9:00 A.M. SHENANDOAH ROOM

1. 9:00 Compatability Relationships in the Convolvulaceae.
   R. J. Knight; *The Blandy Experimental Farm*
2. 9:15 Preliminary Studies of Cavernicolous Fungi.
   William W. Scott and Margaret M. Holland; *Virginia Polytechnic Institute*
3. 9:30 The Saga of Virginia's Water Lily.
   Agnes K. Beall and Elinor T. Wayne; *Rutgers University and Madison College*
4. 9:45 A Comparative Study of the Phallic Papilla of Four Genera of Crayfishes of the Family Astacidae.
   Thomas L. Johnson; *University of Virginia*
5. 10:00 Wildlife in the Pre-colonial Period.
   John H. Reeves; *Virginia Polytechnic Institute*
6. 10:15 Host Specificity and *Odostomia impressa*, Say.
   J. Frances Allen; *University of Maryland*
7. 10:30 General Considerations in Laboratory Animal Care.
   Berton F. Hill; *Executive Secretary, Institute of Laboratory Animal Resources; National Academy of Sciences* (by invitation)
8. 11:15 Salinity and Oxy-hemoglobin Affinity.
   Jack D. Burke; *University of Richmond*
9. 11:30 The Effect of Ultra-violet and X-radiation on the Growth of *Phleum pratense* roots.
   Robert T. Brumfield; *Longwood College*
10. 11:45 Preliminary Studies on the Effects of Potassium Gibberellate on Growth Phases of Mosses.
    Paul M. Patterson; *Hollins College*
11. 12:00 Cytological Studies in *Setcreasea purpurea* Boom and *S. brevifolia* (Torr.) Rose

Smritimoy Bose; *The Blandy Experimental Farm, University of Virginia*

12. 12:15 Selection of the Large Milkweed Bug for Resistance to Insecticides.
James McDonald Grayson; *Virginia Polytechnic Institute*

13. 12:30 Seasonal Influences on Certain Features of the Anatomy of the Skin of Sheep and Goats.
Lubow A. Margolena; *United States Department of Agriculture, Beltsville, Maryland*

12:45 Section Business Meeting

14. 2:15 Short-Term Survival in Pen-reared Quail.
Thomas H. Ripley and Russell A. Cookingham; *Virginia Polytechnic Institute*

15. 2:15 Infraspecific Variations in the White Perch, *Roccus americanus* (Gmelin).
William S. Woolcott; *University of Richmond*

16. 2:30 To be announced.
Donald L. McKernan, Director, Bureau of Commercial Fisheries; U. S. Game and Wildlife Service (by invitation)

17. 3:15 The Exoskeleton of a Freshwater Crab as a Microhabitat for Several Invertebrates.
Horton H. Hobbs, Jr. and Alejandro Villalobos; *University of Virginia*

18. 3:30 Native Shrubs of Virginia.
Arthur L. Eiser; *Virginia Polytechnic Institute*

19. 3:45 Grasses of Virginia.
A. B. Massey; *Virginia Polytechnic Institute*

20. 4:00 Studies on Evolutionary Divergence of the Floras of Southeast Asia and the Southeastern United States.
Mary Jo Parrish; *Mary Washington College*

21. 4:15 Blood Oxygen Capacity in Frogs.
Frank Leftwich; *University of Richmond*

22. 4:30 A Preliminary Survey of the Ciliated Protozoa from Tree Borne Mosses and Lichens in the Mountain Lake Area.
Jesse C. Thompson, Jr.; *Hollins College*

23. 4:45 Chromosome Sequence Change and in Inversion Bridge in *Rhoeo discolor.*
R. O. Flagg; *University of Virginia*

Section of Chemisty

Joe C. Holmes, *Chairman*

Frank A. Vingiello, *Secretary*

Merle A. Kise, *Section Editor*

FRIDAY, MAY 9, — 9:00 A.M. — BALLROOM

9:00 Announcements; Introductory Remarks

1. 9:15 Neutron Diffraction Observations on the Palladium-Hydrogen and Palladium-Deuterium Systems.
James E. Worsham, Jr., M. K. Wilkinson and C. G. Shull; *University of Richmond, Oak Ridge National Laboratory* and the *Massachusetts Institute of Technology*

2. 9:30 Aggregation Studies of Soybean Protein.
Carl J. Likes; *Virginia Institute for Scientific Research*

3. 9:45 The Use of Low Voltage Mass Spectroscopy in Qualitative Analysis of Organic Compounds.
Charles Varsel, Francis A. Morrell, Frank E. Resnick, and W. Allan Powell; *Philip Morris, Inc.*, and the *University of Richmond*

4. 10:00 The Use of Infrared Spectrophotometry in the Analysis of Piperazine Salts.
William R. Maynard, Jr.; *Division of Chemistry and Foods, Virginia Department of Agriculture*

5. 10:15 A Rapid Spectrophotometric Determining of Total Alkaloids in Tobacco Smoke.
Charlotte Haynes and Sylvester Pleasants; *Philip Morris, Inc.*

10:30 Recess

6. 10:45 Spectrochemical Determination of Certain Trace Elements in Human Plasma and Red Cells.
Leonel M. Paixao and John H. Yoe; *Pratt Trace Analysis Laboratory, Department of Chemistry, University of Virginia*

7. 11:00 Spectrophotometric Determination of Chromium in Human Plasma And Red Cells.
Dwight O. Miller; *Pratt Trace Analysis Laboratory, Department of Chemistry, University of Virginia*

8. 11:15 Some Derivatives of Dithiooxamide as Reagents for the Simultaneous Spectrophotometric Determination of Traces of Cobalt, Nickel and Copper.
William D. Jacobs; *Pratt Trace Analysis Laboratory, Department of Chemistry, University of Virginia*

9. 11:30 Spectrophotometric Determination of Aluminum with Quinizarin -2,3-Disulfonic Acid Na-Salt.
E. Guy, Owens, II and John H. Yoe; *Pratt Trace Analysis Laboratory, Department of Chemistry, University of Virginia*

10. 11:45 Spectrophotometric Determination of Uranium with 3- (2-Arsonophenzlazo)-4,5-Dihydroxy – 2, 7- Naphth-alenedisulfonic Acid (Trisodium Salt).
H. Perry Holcomb and John H. Yoe; *Pratt Trace Analysis Laboratory, Department of Chemistry, University of Virginia*

12:00 Business Meeting

11. 2:00 Reaction of Ethylene Oxide with Histidine, Methionine and Nicotinic Acid.
H. G. Windmueller and C. J. Ackerman; *Department of Biochemistry and Nutrition, Virginia Polytechnic Institute*

12. 2:15 Imide and Hydrazide Plant Hormones.
Lowell V. Heisey; *Department of Chemistry, Bridgewater College*

13. 2:30 Aromatic Cyclodehydration on Solid Surfaces.
Frank A. Vingiello and Martin Sprangler; *Department of Chemistry, Virginia Polytechnic Institute*

14. 2:45 Preparation of Some Cyclic Sulfones from 1,3-Pentadiene.
Robert C. Krug and James A. Rigney; *Department of Chemistry, Virginia Polytechnic Institute*

15. 3:00 Physical Properties of Systems of Toluene and Water Containing Glycol Ethers.
Newton C. Landis and Nelson F. Murphy; *Department of Chemical Engineering, Virginia Polytechnic Institute*

16. 3:15 Kinctics of the Acid Catalyzed Cyclization of o-Benzylbenzophenone in Acetic Acid-Water Mixtures.
L. K. Brice, Jr. and R. D. Katstra; *Department of Chemistry, Virginia Polytechnic Institute*

17. 3:30 The Acid Catalyzed Depolymerization of Trioxane in Concentrated Hydrochloric Acid Solutions. Salt Effects and Correla-

tion with Ho.
L. K. Brice, Jr. and L. P. Lindsay; *Department of Chemistry, Virginia Polytechnic Institute*

18. 3:45 The Heat of Sublimation of Boron and the Gaseous Species of the Boron-Boric Oxide System.
Alan W. Searcy and Clifford E. Myers; *Department of Chemistry, Lynchburg College*

19. 4:00 Surface Rearrangements Produced on a Copper Monocrystal by the Catalytic Reaction of Hydrogen and Oxygen.
Richard Y. Meelheim; *Department of Chemistry, University of Virginia.*

20. 4:15 Corrosion Inhibition and Activation of Iron and other Metals by Metallic Cations in Fruit and Mineral Acids.
Roger Buck; *Virginia Institute for Scientific Research*

21. 4:30 An Unusual Elbs – Type Reaction Observed during a Study of the Cyclization of Ketones.
Frank A. Vingiello, Alexej Borkovec and Walter Zajac, Jr., *Department of Chemistry, Virginia Polytechnic Institute*

Section of Education

Evan G. Pattishall, *Chairman*

Charles Turner, *Secretary*

James B. Patton, Jr.; *Section Editor*

FRIDAY, MAY 9 – 9:00 A.M. – PARLOR K

1. 8:30 Registration

2. 9:00 The Conservation Knowledge of Virginia School Pupils.
Robert H. Giles, Jr.; *Virginia Commission of Game and Inland Fisheries*

3. 9:25 Some Characteristics of Youth Enrolled in an Institution for the Hard of Hearing.
Alonzo M. Myster; *Virginia State College*

4. 9:50 Validation of the Wert-Myster Farming Attitude Scale in a Group of High School Pupils in Virginia.
Alonzo M. Myster; *Virginia State College*

5. 10:15 Recess

6. 10:30 Development of Interests in Elementary School as Studied by a Pictorial Interest Schedule.
Shelva Dove and George W. Kent; *Bridgewater College*

7. 10:55 The Prediction of Academic Achievement in College by a Motivation Index.
Norman Rebert and George W. Kent; *Bridgewater College*

8. 11:20 A Word-Color Association Test.
Harry S. Beck; *University of Virginia*

9. 11:45 The Application of Operations Research to Educational Problems.
John M. Long; *University of Virginia*

10. 12:10 What Becomes of Boys Who Study Vocational Agriculture in the High School?
H. W. Sanders; *Virginia Polytechnic Institute*

11. 12:35 The Human Governor: Cybernetics and Communication Theory.
David Redfield; *University of Virginia*

12. 1:00 Business Meeting and Election of Officers

13. 1:30 Adjournment

Section of Engineering

Otis L. Updike, Jr.; *Chairman*

Arthur C. Bruce, *Secretary*

Robert M. Hubbard, *Section Editor*

FRIDAY, MAY 9 — 9:10 A.M. — PARLOR E

1. 9:10 Aerodynamic Characteristics of a Hemisphere in Newtonian Flow.
E. Brian Pritchard; *Virginia Polytechnic Institute*

2. 9:30 Characteristics of Complete Aircraft Configurations at Hypersonic Speeds.
Robert W. Truitt and William Grossmann; *Virginia Polytechnic Institute*

3. 9:50 Minimum-Dray Configurations at Hypersonic Speeds.

Robert W. Truitt and Thomas H. Thornton, *Virginia Polytechnic Institute*

4. 10:10 Longitudinal Stability Derivatives of Missile-Shaped Bodies at Hypersonic Speeds.
Robert H. Tolson and James B. Eades, Jr.; *Virginia Polytechnic Institute*

5. 10:30 Some Aspects of Magnetohydrodynamics.
Robert W. Truitt and Richard D. Wagner; *Virginia Polytechnic Institute*

6. 10:50 Aeronautical Applications of Magnetohydrodynamics.
Robert W. Truitt and Norris E. Mitchell; *Virginia Polytechnic Institute*

7. 11:10 The Effect of Heat Insulation on the Internal Cooling Requirements of High Speed Vehicles.
John N. Perkins; *Virginia Polytechnic Institute*

8. 11:30 Joining Aluminum with High Zinc Solders by Abrasion.
O. R. Singleton, Jr.; *Metallurgical Research Laboratory*, Reynolds Metal Company, Richmond, Virginia.

12:00 Presentation of Engineering Award at the meeting of the Junior Academy of Science.

9. 2:00 Drag Reduction by Blunting.
Robert W. Truitt and Clairborne R. Hicks; *Virginia Polytechnic Institute*

10. 2:20 A Correlation for Drag Coefficient at Transonic Speeds — Axially Symmetric Flow.
James B. Eades, Jr.; *Virginia Polytechnic Institute*

11. 2:40 A Comparison of the Rate of Heat Transfer through Flat Plates and Cylindrical Shells.
Samuel C. Wilson and John N. Perkins; *Virginia Polytechnic Institute*

12. 3:00 Minimum-Drag Bodies in the Superaerodynamic Region.
Robert W. Truitt and C. Howard Robins; *Virginia Polytechnic Institute*

13. 3:20 Artificial Satellite Spiral Descent Mechanics.
James T. McDaniel and A. C. Bruce; *Virginia Polytechnic Institute*

14. 3:40 Vehicle Mechanics in an Earth-Moon Gravity Field.

John W. Barnes and A. C. Bruce; *Virginia Polytechnic Institute*

15. 4:00 Escape Trajectory for a Vehicle in the Earth-Moon Gravity Field.
Lester W. Roane and A. C. Bruce; *Virginia Polytechnic Institute*

16. 4:20 Engineering Exhibits.
Presented by Members of the Virginia Junior Academy of Science.

5:20 Business Meeting and Election of Officers.

SATURDAY, MAY 10 — 9:00 A.M.

17. 9:00 Decolorization of Caustic Wash Liquors From Chlorine-Bleached, Sulfate Wood Pulp.
Peter W. Ruggieri, Jr. and N. F. Murphy; *Virginia Polytechnic Institute*

18. 9:15 Overall Mass Transfer Coefficients for a Homologous Series of Poly-Glyco lEthers between Toluene and Water.
Robert H. Pusey and N. F. Murphy; *Virginia Polytechnic Institute*

19. 9:30 Studied in Absorption using Molecular Sieves.
C. R. Price, P. H. Terry and F. W. Bull; *Virginia Polytechnic Institute*

20. 9:45 A Continuous Countercurrent Absorber for Instructional Purposes.
S. A. Burnette, J. S. Chowning and F. W. Bull; *Virginia Polytechnic Institute*

21. 10:10 Evaluation of Factors Affecting the Extraction Efficiency of an Experimental Pulse, Liquid-Liquid Extractor.
D. L. Merrill, R. M. McEachern, R. E. Wood and F. W. Bull; *Virginia Polytechnic Institute*

22. 10:15 True Averaging, Non-Saturating Electro-Pneumatic Conversion.
Walter P. Walker and Henry R. Blane; *University of Virginia Engineering Experiment Station*

23. 10:30 Research on Focusers for Molecular Oscillators.
Kenneth L. Haynes, R. L. Ramsey and O. R. Harris; *University of Virginia Engineering Experiment Station*

24. 10:50 Evaluation of High Temperature Antioxidants.
Dennis M. Frame and James W. Cole, Jr.; *University of Virginia*

25. 11:10 Application of Analog Computing Equipment to Extraction Calculations.
Patricio Castro and Otis L. Updike; *University of Virginia*

26. 11:30 Mechanisms of the Low Pressure Polymerization for Ethylene to Polyethylene.
Y. K. Pan and Frank C. Vilbrandt; *Virginia Polytechnic Institute*

27. 11:40 The Separation of a Hydrogen-Carbon Dioxide Mixture by Gaseous Diffusion.
Russell A. Primrose and Frank C. Vilbrandt; *Virginia Polytechnic Institute*

28. 11:55 Mechanisms by which Ultrasonics Energy Affects Transfer Rates in Liquid-Liquid Extraction.
Hughey A. Woodle and Frank C. Vilbrandt; *E. I. du Pont de Nemours and Company* and *Virginia Polytechnic Institute*

Section of Geology

R. V. Dietrich, *Chairman*

J. T. Hack, *Vice-Chairman*

R. S. Mitchell, *Secretary*

W. D. Lowry, *Section Editor*

FRIDAY, MAY 9 — 9:00 A.M. — PARLOR F

9:00 Announcements

1. 9:10 What is "Basement Complex" in Virginia?
C. E. Sears; *Virginia Polytechnic Institute*

2. 9:30 Silurian of Virginia: A Review.
C. G. Tillman; *Virginia Polytechnic Institute*

3. 9:50 The Geomorphic Significance of Residual and Alluvial Deposits in the Shenandoah Valley, Virginia.
J. T. Hack; *United States Geological Survey*

4. 10:10 A Further Discussion of the Saltville Fault in Smyth and

Washington Counties, Virginia.
W. A. Nelson; *University of Virginia*

5. 10:25 A Stratigraphic and Petrographic Study of the Acid Lava Flow in the Basal Unicoi from Rockfish Gap to Swift Run Gap.
R. G. Roane and W. C. Sherwood; *University of Virginia*

6. 10:40 A Petrographic Analysis of the Mosheim Formation at Strasburg, Virginia.
W. C. Sherwood; *Virginia Council of Highway Investigation and Research*

7. 10:55 Pre-Middle Ordovician Channels in the Knox near Meadowview, Virginia.
L. P. Harris; *Virginia Polytechnic Institute*

8. 11:10 Mineral Occurrences and Associations in the Albemarle Crushed Stone Quarry (Catoctin Formation) near Shadwell, Virginia.
W. F. Giannini and W. K. Rector, Jr.; *University of Virginia*

9. 11:25 Remarks on a Carbonate-Derived Gossan near Stony Point, Virginia.
J. F. Tazelaar; *University of Virginia*

10. 11:40 Mineral Transformations in Sediments of the Rappahannock Estuary, Virginia.
B. W. Nelson; *Virginia Polytechnic Institute*

12:00 Recess

11. 2:00 Program of the Division of Mineral Resources.
J. L. Calver; *Division of Mineral Resources*

12. 2:10 Some Worthies in Geology.
J. K. Roberts; *University of Virginia*

13. 2:30 Symposium on Silica.
Introduction. R. V. Dietrich; *Virginia Polytechnic Institute*

14. 2:40 The Use of Silica Sand for Providing Skid Resistance to Highway Surfaces.
J. L. Eades; *Virginia Council of Highway Investigation and Research*

15. 3:00 Implications of Smoky Phantoms in Rock Crystal Quartz near Craigsville, Virginia.
Whitman Cross, II and R. K. Peare; *University of Virginia*

16. 3:20 Conjugate Quartz Veins in the Lynchburg Gneiss near Fancy

Gap, Carroll County, Virginia.
B. H. Richard; *Virginia Polytechnic Institute*

17. 3:40 Cementation of Quartzose Sandstones of Virginia.
W. D. Lowry; *Virginia Polytechnic Institute*

18. 4:00 Chert Pebbles in a Basal Unicoi Conglomerate.
R. V. Dietrich; *Virginia Polytechnic Institute*

4:20 Business Meeting

Section of Medical Science

FRIDAY, MAY 9, – 10:00 A.M. – CAVALIER ROOM

Cornelia Hoch-Ligeti, *Chairman*

Robert H. Brownson, *Secretary*

W. Parker Anslow, Jr., *Section Editor*

1. 10:00 A Method for the Standardized Production of Irreversible Shock Following Hemrorhagic Hypotension in the Cat.
Eugene D. Brand; *University of Virginia*

2. 10:15 A Relationship between Molecular Structure and Stimulation of Muscle Metabolism.
D. R. H. Gourley; *University of Virginia School of Medicine*

3. 10:30 The Growth of Thyroidectomized Rats given 3,3',5-triiodothyronine.
C. L. Gemmill; *University of Virginia School of Medicine*

4. 10:45 Studies on the Effects of Scurvy and Inanition on the Male Reproductive Tract.
L. F. Cavazos; *Medical College of Virginia*

5. 11:00 Some Effects of X-irradiation on the Guinea Pig Brain with Reference to the Age Factor.
R. H. Brownson; *Medical College of Virginia*

6. 11:15 Motion Pictures of Changes in Cells Induced by X-Ray Treatments of Tadpoles and Tetrahymenae.
Carl C. Spiedel; *University of Virginia School of Medicine.*

11:30 Business meeting.

7. 1:30 Tissue Cultures from Human Adult Bronchial Epithelium.
Cornelia Hoch-Ligeti, *University of Virginia School of Medicine*

8. 1:45 Effects of Amphenone Administration on the Adrenal Response of Rats to Alcohol Intoxication.
J. C. Forbes and G. M. Duncan; *Medical College of Virginia*

9. 2:00 A "New" Agglutinin against Stored Erythrocytes.
Cecil Hougie; *University of Virginia School of Medicine*

10. 2:15 Effect of Temperature on Secretory Activity and Oxygen Consumption of Isolated Frog Skin.
Ernst G. Huf and Norma S. Doss; *Medical College of Virginia*

11. 2:30 A Cell for Osmosis and Diffusion Studies of Isolated Secretory Membranes.
Addison D. Campbell, Thomas E. Gilmer and Ernst G. Huf; *University of Richmond, Experiment Incroporated,* and *Medical College of Virginia*

12. 2:45 An Apparatus for the Study of Isolated Secretory Membranes of Automatically Controlled Membrane Potentials.
Thomas E. Gilmer, Addison D. Campbell and Ernst G. Huf; *Experiment Incorporated, University of Richmond,* and *Medical College of Virginia*

13. 3:00 Metabolic Studies on Isolated Epithelium of Frog Skin.
Leif Skjelkvale, Kathryn Nieder and Ernst G. Huf; *Medical College of Virginia*

14. 3:15 Ion Activities with Presence of Kidney Bries.
Sidney Solomon; *Medical College of Virginia*

Section of Psychology

Noble R. McEwen, *Chairman*

William E. Harris, *Executive Committeeman*

Penelope Lewis, *Secretary-Treasurer*

John K. Bare, *Section Editor*

FRIDAY, MAY 9 — 10:15 A.M. — POCAHONTAS ROOM

1. 10:15 Analysis of Variables Affecting Tracking Performance.
Harold S. Schaus, Jr.; *University of Virginia*

2. 10:30 A Follow-up Study of School Related Referrals.
Roberta Kiefer Simmons; *Norfolk Mental Hygiene Center*

3. 10:45 Variations of Whole-Part Methods of Learning and Experimenters.
F. J. McGuigan; *Hollins College*

4. 11:00 Panel Discussion: The Improvement of the Teaching of Psychology.
Moderator: Frank W. Finger; *University of Virginia*

5. 1:30 Cutaneous Electrical Delta I.
Glenn R. Hawkes; *University of Virginia*

6. 1:45 Cutaneous Frequency Discrimination.
Genevieve D. Goff; *University of Virginia*

7. 2:00 The Selection of Scientific Talent.
Antonia B. Morgan; *Aptitudes Associates, Inc.*

8. 2:15 Stimulation of Discomfort and Relief in Written Documents.
Dell Lebo and William Applegate; *Richmond Professional Institute.*

9. 2:30 The Control of Olfactory Stimuli.
William R. Goff; *University of Virginia*

10. 2:45 Intermission

11. 3:00 Symposium: Achievement Imagery as Measured by the Iowa Picture Interpretation Test. *Chairman*: Robert A. Johnson; *Chairman*: Robert A. Johnson; *University of Richmond*
A Further Investigation of the Effects of Achievement Imagery and Instructions on Maze Learning Performance.
Ann Hunter; *University of Richmond*
A Psycholinguistic Analysis of Speech Behavior in Groups Differing in Achievement Imagery.
Rudolph F. Wagner; *Richmond Public Schools;* and John E. Williams; *University of Richmond*
Achievement Imagery and A. C. E. Scores as Predictors of Grades in General Psychology.
John E. Williams; *University of Richmond*
Moderator: Stanley B. Williams; *College of William and Mary*

12. 4:15 Business Meeting: Virginia Psychological Association.
William J. Morgan; *President*
Gilbert J. Rich; *Vice-President*
Cora Lynn Goldsborough; *Secretary*
Jacob Silverberg; *Treasurer*

13. 6:00 Virginia Psychological Association Dinner at Toby's Lodge.
Address: Current Legislature Problems for Psychologists.
Speaker: Thomas W. Magoon; *University of Maryland*
Dr. Magoon is President-elect of the Maryland Psychological Association and Co-chairman of the Legislative Committee of the Conference of State Psychological Associations.
Transportation to Toby's Lodge will be provided. Members of the Section of Psychology are cordially invited to attend the dinner.

SATURDAY, MAY 10 — 9:15 A.M.

14. 9:15 Pupillary Dilation to Spectral Stimuli.
Robert H. Gibson; *University of Virginia*

15. 9:30 The Influence of Water Deprivation and Saline Injection Upon Thirst Behavior.
James F. Campbell, Jr.; *University of Virginia*

16. 9:45 The Parental-Pathogens Test.
Harold E. Paine; *Memorial Guidance Clinic*

17. 10:00 A Question: Who Should be the Patient?
A. W. Jeffreys, Jr.; *Western State Hospital*

18. 10:25 Intermission

19. 10:35 A Repetition of the Miller Experiment on Acquired Fear.
Raymond Kirby; *College of William and Mary*

20. 10:45 An Investigation of Taste Variables.
John B. Feallock; *University of Virginia*

21. 11:00 Deprivation and the Day-night Cycle as Determiners of Food Intake.
George Cicala; *College of William and Mary*

21. 11:15 Business Meeting: Section of Psychology.
Noble R. McEwen, *Chairman*

Section of Science Teachers

Vera B. Remsburg, *Chairman*

Mae Jennings, *Chairman-elect*

A. B. Niemeyer, Jr., *Secretary*

Caroline Gambrill, *Section Editor*

THURSDAY, MAY 8, 1:00 P.M. — PINE ROOM

1. 1:00 Present Status of Secondary Science in Virginia.
   Mr. Franklin D. Kizer — *Assistant Supervisor of Secondary Education*

2. 1:30 An Experiment in Science Education.
   Mary E. Kapp; *Richmond Professional Institute*

3. 2:00 Symposium on Quantitative Measurements in the Teaching of Science at All Levels.
   Moderator: James W. Cole, Jr.; *Director Academic Year Institute*. Members of the staffs of various science departments and participating teachers from the national Science Foundation Academic Year Institute of the University of Virginia will outline briefly some of the problems and present demonstrations of basic measurements in the fields of biology, chemistry, earth sciences and physics. Discussions of the topics will be from the viewpoint of classroom teachers.

4. 1:00 Teaching Materials. Booth 7.
   Demonstrator: A. B. Niemeyer

Section of Statistics

N. L. Enrick, *Chairman*

J. W. Griswold, *Vice-Chairman*

R. A. Bradley, *Secretary*

C. Y. Kramer, *Section Editor*

FRIDAY, MAY 9 — 9:00 A.M. — WRITING ROOM

1. 9:00 Introductory Remarks by the Chairman.

2. 9:05 Combined Inter-and Intra-Block Analysis for Factorials in Incomplete Block Designs.
R. E. Walpole; *Roanoke College*

3. 9:30 The Use of Response Surface Analysis on Biological Material.
D. C. Hurst; *Virginia Polytechnic Institute*

4. 9:55 Triangle, Duo-Trio, and Difference from Control Tests in Taste Testing.
R. A. Bradley; *Virginia Polytechnic Institute*

10:20 Intermission.

Session on Industrial Statistics

5. 10:30 Introduction to Statistical Sampling Inspection.
G. F. White, Jr.; *Reynolds Metal Co.*

6. 10:55 Application of Variance-Length Curves in Product Quality Analysis.
William D. Hicks; *Fieldcrest Mills*, Leaksville, N. C.

7. 11:20 Methodology for the Improvement and Analysis of Unsatisfactory Condition Data on a Complex Automatic Electro-Mechanical System.
James R. Duffett; *Virginia Polytechnic Institute*

8. 2:00 Analysis and Reduction of Variations in the Processing Plant.
N. L. Enrick; *Institute of Textile Technology*

9. 2:30 Application of Linear Programming to Dope Metering Pump Replacement.
J. W. Cowdery; *Celanese Corporation of America*

10. 3:00 Business Meeting.

11. 3:30 Errors Associated with Process Adjustments.
J. Edward Jackson; *Virginia Polytechnic Institute*, and R. A. Freund and W. G. Howe; *Eastman Kodak Co.*

12. 4:00 A Designed Experiment to Evaluate Seven Yarn Lubricants.
H. M. Hill; *Tennessee Eastman Co.*

SATURDAY, MAY 10 — 9:00 A.M.

13. 9:00 Analysis of Variance of a Randomized Block Design with Missing Observations.
W. A. Glenn and C. Y. Kramer; *Virginia Polytechnic Institute*

14. 9:25 Analysis of Variance of a Latin Square Design with Missing Observations.

Susan Glass; *Roanoke College* and C. Y. Kramer; *Virginia Polytechnic Institute*

15. 9:40 Significance Tests in Paired Comparisons.
T. H. Starks and H. A. David; *Virginia Polytechnic Institute*

10:05 Intermission.

16. 10:15 Generalized Distributions and the Problem of Confidence Statements in Multivariate Analysis.
Rolf Bargmann; *Virginia Polytechnic Institute*

17. 10:40 Some Probability Theory of Tests of Varied Components.
C. W. Clunies-Ross; *Virginia Polytechnic Institute*